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ABSTRACT

Natural environments on school sites provide considerable multi-disciplinary educational opportunities, many of which are "hands-on" experiences that stimulate learning. This document presents guidelines on conserving and enhancing the natural environment on school sites. It provides guidance for developing the site requirements in education specifications and designs for new building construction and major renovation and/or addition projects for existing schools. Appendices address funding sources available to Maryland educators to support school site habitat projects; and Maryland organizations that can offer assistance such as the forestry service, soil conservation district offices; and a list of data about Maryland native plants. (Contains 55 references.) (GR)

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Conserving and Enhancing the Natural Environment

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A Guide for Planning, Design, Construction, and Maintenance on New & Existing School Sites

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MARYLAND STATE DEPARTMENT OF EDUCATION

Division of Business Services
School Facilities Branch

Division of Instruction & Staff Development
Arts and Sciences Branch

1999

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Conserving and Enhancing the Natural Environment

A Guide for Planning, Design, Construction, and Maintenance on New & Existing School Sites

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FOREWORD

Our perception of a public school site has changed from a limited educational resource, primarily supporting physical education and recreational activities, to a rich outdoor classroom supporting all aspects of the curriculum. Conserving and enhancing the natural environment on school sites in the form of forests, wetlands, meadows, streams, rain gardens, or native landscaping meets this vision. Natural environments on school sites provide a wealth of multi-disciplinary educational opportunities, many of which are "hands-on" experiences that stimulate learning.

Guidelines on conserving and enhancing the natural environment on school sites are presented to assist local school system staff, architects, landscape architects, engineers, and others involved in the school facility construction planning process. They are also provided to aid local school system staff, particularly at the school level, parents, and other community members in implementing school site projects without a concurrent construction project.

The way in which we conserve, develop, and use our school sites provides, by example, an environmental ethic to students. These guidelines promote a positive stewardship of the natural environment on school sites which, in turn, provides students with ecological and conservation principles that they can apply as adults.

Nancy S. Grasmick
State Superintendent of Schools

Chapter 1

Conservation and Enhancement of the Natural Environment

Introduction

The vision of what a school site should be has changed. The vast potential of a school site to support educational programs is being realized. It is no longer primarily a series of grassed areas and play fields designed for physical education activities and recreation, with landscaping in proximity to the building. Teachers and administrators, parents and neighbors, and most importantly students, have new ideas regarding what a school site should look like and how it should be used. Teachers and parents want a rich, diverse site that supports many facets of their educational mission. Students want a site that they can be proud of, a site that excites them, and that helps stimulate and lend reality to learning. School neighbors want a site that is pleasing to the eye and adds value to the community. Environmental regulations create new challenges and opportunities for both new and existing sites. Projects that conserve or enhance the natural environment can satisfy all of these expectations. Schoolyard projects will vary in size and complexity depending on site conditions, available funding, and the desired long term maintenance.

Purpose

The purpose of these guidelines is to assist local school system personnel, architects, landscape architects, engineers, and others involved in the school facility planning process. This publication will provide guidance for developing the site requirements in educational specifications and designs for new building construction and major renovation and/or addition projects for existing schools.

These guidelines will also assist local school system staff, particularly at the school level (e.g., principals and teachers), parents, and other community members to conceptualize and implement school site projects without a concurrent construction project.

The Importance of Conserving and Enhancing the Natural Environment

School sites should be designed or modified to conserve or enhance the natural environment. The benefits are threefold: educational, environmental, and financial.

Educational Benefits

The educational benefits of school sites with diverse grounds can be divided into two areas - curricular/ instructional benefits and affective benefits. These are easily achievable and together have a large impact on the learning potential of students.

Curricular/Instructional Benefits: Using school sites in support of curricular and instructional goals is important. Conserving and enhancing the natural environment on school sites directly supports the goals in the environmental education bylaw (Code of Maryland Regulations 13A.04.17) of the State Board of Education. The bylaw defines the requirements of a multidisciplinary environmental education program that must be provided to students.

Using basic skills to solve real-world, authentic problems is fundamental to the success of accountability programs such as the Maryland School Performance Assessment Program (MSPAP). Many of the highest scoring schools and some of the first schools to meet state performance standards on MSPAP make extensive use of the school site. Using the rich learning opportunities presented by meadows, gardens, trees and forests, and wetlands or ponds on the school site can bring authenticity, excitement, and valuable educational resources to an instructional program.

Another important purpose in conserving and enhancing the natural environment in the schoolyard is to instill an environmental ethic by example -- not just by words in a textbook. As we teach environmental

> "If students learn about ecological principles in the schoolyard, perhaps children will grow up to apply these principles in their communities and in their own backyards."

education, we should practice conservation principles in the landscape around us. We should understand the environmental impact of clearing the vegetation from our school sites and replacing native ecosystems with acres of grass. If students learn about ecological principles in the schoolyard, perhaps children will grow up to apply those principles in their communities and in their own backyards.

Affective Benefits: Are students, parents, teachers, and neighbors proud of what the school site looks like? Are the school grounds aesthetically interesting? Is the school site unique in some manner, separating it from other schools? The school site can have a dramatic role in the development of student, teacher, and parent attitudes about the school and learning. Are there natural events happening at the site that can interest both teachers and students? Many schools have increased parental and community interest and participation in school activities by involving parents in a school site environmental restoration project.

Environmental Benefits

Recent State environmental regulations regarding trees, forested areas, wetlands, streams, and sediment/stormwater control require the development of new school site environmental management options. Later chapters in this publication on rain gardens, meadows, and wet-pond sediment/stormwater management options will detail examples of how environmental regulations can be met in ways that help the environment, save maintenance dollars over the long term, and provide important learning opportunities for students.

Two of the many benefits that natural areas provide include wildlife habitat and stream protection. Habitat for wildlife is increased by converting lawns, having low habitat value, to rich native plant communities, including meadows, forests, or wetlands. Streams, and ultimately the Chesapeake Bay, greatly benefit by having natural habitats in their watershed as vegetation and leaf litter promote the infiltration of rainwater restoring a critical part of the water cycle-groundwater. Groundwater slowly seeps into streams providing the clean, cool waterflow necessary for all aquatic life.

Some Maryland jurisdictions use schools as sites for forest and wetland environmental mitigation projects. Some counties do this because they have a shortage of potential local mitigation sites and others because this is a simple, often very inexpensive way to enhance the school site aesthetics and usefulness for learning.

Financial Benefits

Enriching the classroom-based learning environment can be expensive. For instance, studying the development of butterfly larva or tadpoles is a typical instructional activity. Does one have to buy the animals from a catalogue and buy the cages and tanks or does one simply observe and study the development of these animals in an on-site meadow, wetland, or pond? Are there opportunities to help students meet service learning graduation requirements through environmental restoration projects on the school site or is transportation or busing provided to sites off campus? Many schools have saved significant funds because they utilize those habitats available at their school.

A school site that is primarily turf has significant maintenance costs and may have little positive impact on the environment. It may, in fact, have a negative effect on the environment. Portions of sites often do not lend themselves to easy mowing and maintenance. Steeply sloped areas and places that are regularly wet can be difficult and often dangerous to mow. Several school systems are realizing significant maintenance savings by converting unused turf to meadows, forests, or wetlands. Although initial costs are sometimes higher for a natural landscape feature, the long term cost savings are usually significant.

Facility planners are interested in the maximum use of building space and the best use of the school site. A survey by the U.S. Fish and Wildlife Service of 50 school sites in Maryland found that the median acreage of unused turf on elementary school sites was 2.7 acres and 4.6 acres for secondary schools. The development of natural habitats on school sites enhances the aesthetic value of the site as well as its student, teacher, and community utilization.

Student Participation

How do you best create a new site, or develop an existing site, into an educationally and environmentally rich place? The answer varies from school site to school site. However, a consistent part of the answer is to involve the students, as fully as possible, in the development and completion of the projects.

Students at Grasonville Elementary (Queen Anne's County) and Hollywood Elementary (St. Mary's County) Schools wrote grant applications to support much of their school site restoration projects. Students at Sussex Elementary School (Baltimore County) and other schools are raising the plants that will be planted on their sites. Students in Harford and Cecil Counties, and in Baltimore City are actively part of forest and riparian forest planting projects that also reduce mowing maintenance costs. Wetlands restoration projects in Anne Arundel, Baltimore, Cecil, Garrett, Harford, Queen Anne's, and St. Mary's Counties have been planned by students. Student, parent, and community involvement strengthens interest and greatly increases the educational value of a project.

Achieving Success

As with any aspect of school design, the goal for school site conservation and enhancement projects is to achieve the maximum benefit for the greatest number of years.

Research from a nonprofit organization in Great Britain called Learning Through Landscapes, found that three important principles need to be followed to realize maximum benefits from a school site conservation or enhancement effort:

Holistic - involving the entire school community and all aspects of the curriculum;

Participative - involving students with adults in as many aspects as possible; and

Sustainable - involving continuing consideration of the use, design, management, and maintenance of school grounds as part of a school's ongoing development and planning.

Judith A. Resnick Elementary School, Montgomery County Public Schools

Chapter 2

The Planning Process

The Process

In planning a major, new, or renovated facility, a school system must translate an educational philosophy into a detailed design. In order to ensure that the facility is well-designed, many points of view and areas of knowledge must be tapped. A planning committee is assembled to bring together individuals with the diverse experience required. The committee will see the project progress through a number of distinct phases, from inception to occupancy. Although the process will vary from project to project, the following steps outline a typical process:

Planning

- Project approval and site selection
- Planning committee and planning subgroup formation
- Committee discussions and decisions on program, philosophy, content, staffing, organization, etc.
- Educational specifications preparation
- Selection of an architect
- Completion of forest stand delineation plan when required

Design

- Pre-design meeting with the architect
- Schematic design
- Design development
- Preparation of construction documents
- Completion of forest conservation plan when required

Construction

- Bidding and contract award
- Construction
- Acceptance of project and occupancy of facility

Occupancy

- Installation of moveable equipment and furnishings
- Occupancy
- Post-occupancy evaluation

Site Selection

The site selection process enables a school system and the State to objectively review the suitability of potential school sites. In addition to local approvals, the approval of the State Superintendent of Schools and the State Interagency Committee on School Construction (IAC) is required for the acquisition of all new sites. Site approvals are required from the following State agencies prior to submittal of the site for IAC and State Superintendent approval.

1. Department of Natural Resources (DNR) will review for issues related to wetlands (tidal and nontidal), endangered species, flood plains, Chesapeake Bay Critical Area, coastal zone consistency, forest and tree impact, recreation and open space, and general natural resources impact.

2. Maryland Department of the Environment (MDE) will review for issues related to water and sewer service, stormwater management, soil erosion, wetlands, presence of hazardous and solid waste, air management, and general environmental impact.

3. Maryland Historic Trust (MHT) will review the status of the site concerning inventoried historic properties, National Register listed properties, and prior archaeological or architectural research conducted in the project vicinity. They will assess the site for potential historic properties that have not yet been identified and provide recommendations on the appropriate treatment.

4. State Highway Administration (SHA) will review for possible future state roads encroachment on the site, access from State roads, and general transportation issues.

The Planning Committee

Most site development projects take place within larger frameworks such as new school construction or major renovation projects. Some projects, however, may be specifically for the conservation or enhancement of the natural environment. In either case, there will be a planning committee which has a key role in the decision making process for the overall project.

The planning committee is a collection of people with diverse interests and knowledge and provides a basis for decisions. Planning committees vary in their size and composition, but all planning committees for new construction or major renovation projects should include, at a minimum, the following:

- school principal
- local school facilities planner
- Maryland State Department of Education (MSDE) school facilities specialist
- local environmental education specialist
- local maintenance specialist
- parents
- local educational program specialists
- teachers
- natural resource specialist

The local school system administration ensures that educational programs, budget constraints, and facilities standards are incorporated into the project. The facilities planner and/or the principal is often responsible for coordinating the process. Even while the project is being developed as a whole entity, each of its programmatic components is studied and developed individually. Development of the site, including conservation and enhancement of the natural environment, will be one of these components.

The MSDE school facilities specialist participates in an advisory role. He/she can serve as a resource on national trends, practices across Maryland, and State-level standards and references. The specialist can also serve as a link to MSDE instructional program specialists and other State agencies.

Planning Committee Recommendations:

1. The roles, responsibilities and authority of each person involved in the facilities planning process should be clearly defined and understood.
2. The difference should be clarified between a recommendation and a decision as it relates to the subcommittee activities and the activities of the planning team as a whole.
3. Ground rules, priorities, and expectations should be established and understood by all participants.
4. A positive climate for the exchange and the expression of individual ideas should be established.

Table 1

For large or complex projects, additional planning committee members may come from other government agencies, neighboring businesses, or the residential community. The planning committee should be involved throughout the entire process of facilities development, although its major impact is in the planning and design phases. Specifically, the committee should participate in the following steps:

- Preparation of educational specifications
- Interpretation of the specifications for the project architect
- Development of alternative schematic design concepts
- Review of schematic design documents
- Review of design development documents
- Review of furniture and equipment lists
- Post-occupancy evaluation

Visits to exemplary facilities may be scheduled for committee members.

Educational Specifications

Educational specifications articulate the physical requirements for the project as an outgrowth of the educational program. They must be consistent with the local educational facilities master plan and the overall project scope, capacity, and budget as approved by state and local agencies. They will guide the architect through the design and construction of the project. It is through the educational specification development process that the planning committee members have input into the conservation of existing natural site features and development of additional natural site amenities.

EDUCATIONAL SPECIFICATIONS CONTENT

1. **Project Rationale**
    - **Introduction**
    - **The community**
    - **School board policies**
    - **Belief statements**
    - **Scope of work, budget and schedule**
2. **The Educational Plan**
    - **Curriculum**
    - **Instructional methods**
    - **Staff support**
    - **Technology**
3. **Project Design Factors**
    - **Site conditions**
    - **Building systems**
4. **Activity Areas**
    - **General overview**
    - **Program functions for each education and service program in the project**
5. **Summary of Spacial Relationships**
6. **Summary of Spacial Requirements (Net and gross square feet)**

Table 2

> Educational specifications should highlight existing natural environments on site and include goals for conserving and enhancing the natural environment.

Educational specifications are a text document describing the site development, educational philosophy, and performance expectations for construction projects. They are needed whether the project involves new construction, additions or renovation, and are formally reviewed at the State level. The content of the specifications for projects should include the elements shown in Table 2. The outline in Table 2 is taken from Appendix D of the *Public School Construction Program (PSCP) Administrative Procedures Guide.* Educational specifications for a project solely focused on conserving or enhancing the natural environment would be abbreviated including only applicable sections.

It is under *Site Conditions* in Section 3 of the educational specifications that the existing natural site features should be described. This information should be taken from the forest stand delineation report required for major construction projects under the Maryland Forest Conservation Act. The forest stand delineation report identifies forest stands, 100-year flood plains, steep slopes, intermittent and perennial streams, stream buffers, non-tidal or tidal wetlands, critical habitats, and soils. When a forest stand delineation report is required, this report should ideally be completed prior to beginning development of the educational specifications, but definitely prior to initiating schematic design.

For school construction projects not requiring a forest stand delineation report, a report identifying similar information on natural site features should be completed for the school system. This information should be used to guide the educational specifications and provided to the project architect. The project architect should reference this information with the intent of identifying and incorporating into the schematic design those portions of the site designated for the conservation or development of natural environments.

A school site project solely for the purpose of conserving or enhancing the natural environment (without a concurrent school construction project) should also include a survey of the existing natural environment on the site. The survey can be accomplished using volunteers, technical assistance from government agencies, contracted services, or a combination of these approaches.

In addition to highlighting existing natural environments on the site, the educational specifications should include goals for conserving and enhancing the natural environment. Members of the planning committee should specify existing natural site features designated for conservation and additional site development that requires investigation during the design phases.

The final educational specifications document is a record of decisions about activities for students, teachers, and administrators, and a description of the site development and building spaces required to support such activities. It becomes the basis from which the project architect proceeds with the design. It also serves as a bench mark for checking the progress of the project and the design's responsiveness to the intended programs.

Design and Construction

After the educational specifications have been completed and approved, the architect begins to transform it into a design for site development and the physical space of the building. In designing a facility, an architect starts with a general, or schematic view of the program and gradually develops a very specific response to the program requirements. The final design product is a set of instructions for contractors. Each design phase builds on the previous work and reflects a dynamic process of interaction between the architect and the planning committee.

Pre-Design - When an architect assumes the responsibility for the design project, he/she assumes a set of requirements. The foundation of these are the educational specifications, but additional requirements are building codes, safety/environmental regulations, local/state standards and procedures, constraints imposed by funding, and existing conditions. Often a preliminary meeting is held to identify and clarify the project requirements and to interpret the specifications for the consulting architect. It is at this meeting that the importance of conservation or enhancement of the natural environment as expressed in the educational specifications should be emphasized. The planning committee, the MSDE school facilities specialists, and the architect should be present.

Schematic Design - The schematic design phase develops two or more preliminary site and building design solutions, each meeting major program goals. Schematic designs are conceptual and derive from requirements set forth in the educational specifications and good architectural and engineering practice. After evaluating alternatives, the planning committee selects one solution which the architect refines through a process of review and revision.

The architect should reference the final forest stand delineation report or other survey provided by the school system. The schematic design should specifically address areas of the site targeted for conservation or enhancement of the natural environment. Access to natural environment study areas should also be shown on the site plan.

> "The schematic design should specifically address areas of the site targeted for conservation or enhancement of the natural environment."

The environmental education and program specialists on the planning committee should monitor the schematic design closely for proper site development and the overall relationships between the site development elements and program spaces in the building.

Design Development - During the design development phase, the basic elements articulated in the schematic design phase are developed and fine-tuned. The site development components are further detailed; building footprint and individual room dimensions are finalized; fixed furnishings and equipment are located; construction details are begun; utilities and systems are developed and located; and all aspects of the project take on greater depth and sharper focus. The planning committee has an important role at this phase because design development represents the first opportunity to get into the details of the design and may be the last practical opportunity to make substantial changes in the project.

Cost estimates, energy analyses, and other data are presented during design development. This phase, like schematic design, will be formally reviewed at the local and state levels.

Construction Documents - During the construction document phase, the architect produces detailed documents which will form the contract for construction. The primary documents are construction drawings and written specifications. All systems and elements will be fully described, including demolition, sitework, structural work, roofing, doors, windows, finishes, equipment, plumbing, heating and cooling, fire protection, lighting, power, and electronic communications. A detailed cost estimate will be prepared. If substantial changes to the design originate outside of the planning committee, they should be brought to the key decision makers of the general committee for evaluation and acceptance.

The forest conservation plan should be completed during this phase and incorporated into the construction documents. The forest conservation plan indicates the amount of forest disturbance, protection methods for the remaining forest, and reforestation or afforestation requirements.

Some natural site features developed in the previous design phases may be incorporated into the construction documents indicating work as "not in contract" to be completed by staff and students after occupancy. A wetland, for example, may be graded in the construction contract with planting not in the contract.

When the construction documents are complete, they will be reviewed at the local level. Locally approved documents will then be reviewed at the state level. Once approved, the project can be bid for construction.

Construction - During the construction of the facility, planning committee involvement is minimal. Significant changes to the project are unusual during construction but do sometimes occur due to unforeseen circumstances. Changes which affect the site development in a substantive way should be brought back to the notice of the appropriate educational and technical staff.

Installation of Furnishings and Equipment - Once the construction is substantially complete, furnishings and equipment are installed. All warranties, operating manuals, training, and servicing of new components and systems must be obtained.

Occupancy and Post-Occupancy Evaluation - After construction is complete, the staff can move into the facility. It is at this point that staff and students will plan and complete habitats that were purposely left incomplete.

A post-occupancy evaluation can be an invaluable learning tool. Typically, a team visits the facility in the second year of occupancy. A checklist forms the basis of the evaluation, but there should be provision for comments from users. The facilities planners will use this information to revise local standards. Future planning committees will benefit from the information.

Interagency Committee on School Construction (IAC) Projects

The State of Maryland provides construction funding to school systems through the Public School Construction Program (PSCP) governed by the IAC. Projects may be funded through the PSCP as part of a new school construction, a renovation, or an addition to an existing school. PSCP staff and staff from supporting agencies - the Maryland State Department of Education, the Maryland Office of Planning, and the Department of General Services - are available to assist in all phases of project development. Refer to the *PSCP Administrative Procedures Guide* for more information.

Locally Funded Projects Requiring Approval by the State Superintendent of Schools

Locally funded school construction projects costing more than $350,000 require the approval of the State Superintendent of Schools. A MSDE School Facilities Specialist participates in all phases of planning and design and coordinates the State review and approval for the following submissions:

- Educational Specifications
- Schematic Design
- Design Development
- Construction Documents
- Contract Award
- Change Orders Over $25,000

Refer to Code of Maryland Regulations (COMAR) 13A.01.02.03

Accessibility for Persons with Disabilities

Public schools must provide access for students with disabilities to all educational programs in the least restrictive manner. They also may not discriminate against employment and public services. Consequently, indoor and outdoor education facilities must be accessible to students, teachers, and public users. Title II of the Americans with Disabilities Act (ADA) requires public schools to comply with either the *Uniform Federal Accessibility Standards* (UFAS) or the *ADA Accessibility Guidelines* (ADAAG). In addition to the federal standards, the Maryland Accessibility Code (COMAR .05.02.02) also applies. Maryland architects and school system facilities planners are familiar with these requirements. They apply to site development related to new construction and building renovations. At least one accessible route must be provided that connects accessible buildings, facilities, and elements on the site. Paths must comply with Section 4.3 of ADAAG/ UFAS (See page 60 in this guide).

Accessibility guidelines were developed around adult needs. Adjustments for small children are sometimes necessary. Final federal guidelines for building elements designed for children's use were published by the U.S. Architectural and Transportation Barriers Compliance Board in January, 1998. They are not enforceable until approved by the Department of Justice but are available to school staff, parents, and designers as advisory guidelines.

Case Study: The Planning Process

Yough Glades Elementary School is a recently opened new school in Garrett County. During the design phase, the school construction team decided to carefully consider how the school site could support good habitat design and how school construction plans might include ways of suporting an instructional program that could take advantage of the school site. Staff from the Maryland State Department of Education and the Department of Natural Resources were asked to visit the site and discuss design options.

The final design situated the school to preserve forested areas and large trees, included an accessible path through the forested area, included a boardwalk that allowed access to a wetland area, and preserved large areas of established meadows. Drainage streams were designed to feed into a wet-pond, rather than a dry-pond, in order to create a pond study area.

Instructional equipment and staff development focused on how to integrate the schoolyard habitat into the school's instructional goals, with a special focus on the Maryland School Performance Assessment Program (MSPAP). Students now survey and monitor native butterfly populations that are supported by an outstanding wildflower meadow. They visit the pond and read about the many different organisms they find there. They are involved in reading, writing, and mathematics activities related to their school site. The meadow greatly reduces costs associated with maintaining large unused turf areas, maintains wetland areas, and combined with the forest protection, reduces non-point runoff into the Youghiogheny Creek.

At Yough Glades Elementary School students, teachers, and the community now enjoy a vital and beautiful school site that was designed to support educational goals, and meet environmental regulations.

Stormwater Drainage Pond
Yough Glades Elementary School
Garrett County Public Schools

Boardwalk Through Wetlands
Yough Glades Elementary School
Garrett County Public Schools

Chapter 3

Site Development Options

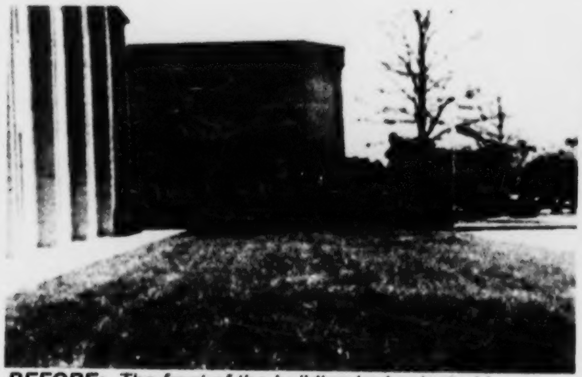
Introduction

Several options for conserving or developing the natural environment on school sites are presented in this chapter. The ideal time to design and construct the suggested options is during new school construction and renovation projects. Many of the projects can be completed on existing school sites without a corresponding building construction project. Where applicable, each section includes a discussion of student participation, safety, regulatory requirements, costs, planning, design, construction, and maintenance. Other documents are referenced where more detailed information is needed. A list of additional references can be found on page D-1.

Finally, significant funding, in kind services, and donated materials are widely available to support projects. Refer to the case studies throughout this section and to Appendix A, Funding Sources, for further information.

Planting a Wetland
North East Middle School
Cecil County Public Schools

NATIVE PLANT LANDSCAPING



BEFORE: *The front of the building is dominated by mown lawn and a few masses of evergreen trees and shrubs.*
U.S. Fish and Wildlife Service Building
Annapolis, Maryland

AFTER: ***Native trees, shrubs, and flowers provide a colorful entrance to the building & attract butterflies and birds.***
U.S. Fish and Wildlife Service Building
Annapolis, Maryland

Case Study: Native Plant Landscaping

Native plant landscaping on school grounds is a relatively new concept although some native plants can be found on most school planting plans. A number of organizations are promoting native plant landscaping for public institutions, corporate and commercial sites, residential communities, and individual homes. Foremost among the local programs endorsing the environmental benefits of native plant landscaping is BayScapes, sponsored by the U.S. Fish and Wildlife Service (USFWS) and the Alliance for Chesapeake Bay. School children have helped install most BayScapes demonstration projects including those at the Maryland Coastal Bays office near Assateague on the Eastern Shore and at Fort George S. Meade in Anne Arundel County.

The overall goal of the BayScapes program is the reduction of nutrient pollution in the Chesapeake Bay. The program recognizes that site development decisions affect water quality in the streams and rivers of our State and ultimately in the Chesapeake Bay. The objectives of BayScapes landscaping are relevant to school sites:

- save money and time by using low maintenance regionally native plants
- reduce the need for fertilizers, herbicides, and pesticides
- conserve water
- save energy and reduce utility bills
- enhance the quality and durability of landscaping
- attract desirable wildlife
- increase enjoyment of the property

The BayScapes installation at the U.S. Fish and Wildlife Services office in Annapolis is an excellent example of what might be accomplished at a school site. The original landscape featured a large panel of grass, with a number of evergreen trees and shrubs lining the walkway to the building entrance. To save costs, most of the original plants were left in place when the native plants were added. As with most BayScapes projects, the first aim was to save energy by reducing mowing and chemical lawn treatments. Thus, much of the grass in front of the building was eliminated and replaced by native plants that will provide a more diverse landscape and attract wildlife.

The new landscape, designed by Marie Erb, a member of the Maryland Native Plant Society, features the lovely spring and summer flowers of serviceberry, sweetbay magnolia, and redbud trees. Native shrubs like the blueberry, arrowwood viburnum, and winterberry holly offer fruit for birds. The garden is colorful from May through October with the blooms of native perennials including blue phlox, coreopsis, purple coneflower, black-eyed susan, gayfeather, butterfly weed, and aster. The little bluestem, a native meadow grass, grows to 4 feet tall and its graceful green stalks turn amber in the fall and remain attractive all winter long.

According to Britt Slattery of USFWS, the advantages of BayScapes go beyond the environmental benefits and attractiveness of the plantings. Not only does a BayScape look a bit different from a conventional ornamental landscape, people react differently to it. "People become involved," she notes. Staff members pull a few weeds as they pass by on their way to or from work, bring in stepping stones to add to the garden, and learn about plants that they can use at home. If someone notices changes in the garden, they spread the word that something new has bloomed or that a new bird or butterfly was seen. Imagine students arriving at school excited by sighting an oriole eating the blueberries, by discovering the first blossom on a magnolia tree, or by spotting a monarch butterfly perched on a coneflower.

The new planting cost $5,000.00 and was installed by a professional contractor, Buzzuto Landscaping. According to Slattery, the installation, if done by volunteers would have cost approximately half that amount for plants, mulch, and ground preparation.

For more information about BayScapes, contact:

U.S. Fish and Wildlife Service
177 Admiral Cochran Drive
Annapolis, MD 21401
(410) 573-4500

Introduction

A schoolyard in Maryland should look different from a schoolyard in New Jersey. Similarly, a school site in Chestertown on the Eastern Shore should have a distinct character from one in Frostburg at the edge of the Appalachian Mountains. Landscaping with native plants can help provide that special identity. By selecting native plants for our school grounds, we link the schools with the landscape of the region reinforcing seasonal cycles and colors. We note the passing of the year as we watch the sequence of flowering in the early spring or the gradual coloring of the forest in the fall. Native plants reinforce our sense of place, a recognition of where we are. By using native plants we are demonstrating that there is an appropriate regional expression for design, whether it is through architecture or landscape architecture.

> "By selecting native plants for our school grounds, we link the schools with the landscape of the region preserving and reinforcing the region's ecosystem."

Imagine it is spring at a school on the Eastern Shore. A large island in the parking lot sports a cluster of red maples and sweetgums underplanted with arrowwood viburnums and highbush blueberries. Flanking the front entrance is a pair of American holly and hedges of bayberry and inkberry line the entrance walk. A pure stand of loblolly pine buffers the school from the neighboring property. The pines provide a backdrop for the large white flowers of the sweetbay magnolia. In the drainage ditch along the road are black willow and large masses of silky dogwoods. The students are studying Native American culture and learning that their arrows were made from twigs of the viburnum, and young willow branches were woven into baskets.

Now, travel to a school in the Hagerstown Valley. It is fall and the entrance driveway is lined with sugar maples that are ablaze with yellow, orange and red leaves. A hedgerow along the property boundary is reminiscent of the local agricultural landscape. Birds enjoy the fruits, seeds and nuts of the serviceberry, blackhaw, cranberry bush viburnum, and hophornbeam in the hedgerow. The landscape is made colorful by the red foliage of the glossy sumac that covers the slopes near the athletic fields, and by the clear yellow leaves of the witchhazels that are massed at the corners of the building. In the spring, a local farmer will be visiting the school to show the children how to tap the maple trees for syrup. They will learn that a few generations ago families might have made jam from the berries of the viburnum and treated skin problems with witchhazel lotion.

Environmental Enhancement

The importance of environmental enhancement of public property is recognized on a federal level and supported at the state level in Maryland. In April 1994, the White House issued an Executive Memorandum on Environmentally Beneficial Landscaping. It recommended that federal properties be planted to complement and enhance the local environment using regionally native plants, minimize adverse effects on natural habitats, and promote the use of plants that conserve water and energy. With the publication of this manual, the Maryland State Department of Education is recommending similar goals for the landscaping of school properties.

Understanding what designates a plant as native is important to the discussion of native plant landscaping. Native plants are those which occur naturally in the landscape of a region or locale. They are sometimes defined as the plants that existed in that landscape prior to the arrival of European settlers. A native plant community is an assembly of trees, shrubs, and groundcovers that have arrived in a certain location and survived due to their adaptability to the landform, microclimate, solar aspect, soil, and water. Protecting and planting native species preserves and reinforces the region's ecosystem. In an ecosystem there is a mutually beneficial relationship between plants and animals. Wildlife is generally dependent upon native plants within its territory for food and cover. In turn, native plants depend on wildlife for pollination. Animals disperse seeds for the continued propagation of plant species. Thus, planting native species contributes to the continuity of this chain of life.

> "A planting plan featuring native plants should be part of a comprehensive landscape design that includes forest conservation, tree preservation, landscaping, and the creation of schoolyard habitat gardens."

Contribution to Educational Programs

The landscaped areas of a school site can provide the stage for numerous educational programs. Plantings can be a source of inspiration for art, writing or other creative activities. They can be used in an environmental science curriculum to teach classes in biology, environmental management, wildlife habitat, pollution prevention, and many other related subjects. Children learn important aspects of ecology when they go outside for lessons that include the use of native plants. They might count how many living creatures they can find in a square meter of lawn, meadow, forest, or garden. They can measure the temperature on a sidewalk and compare it to the temperature on the grass and under a tree. Using the schoolyard as a classroom requires the commitment of administrators and teachers to integrate the outdoor environment into the education program. Bringing students outdoors can result in active learning, an exciting experience for children and teachers alike.

Planning, Design, and Construction

Planning for native species at a new school site first requires analysis of the site conditions and an inventory of existing plants. The Maryland Forest Conservation Act requires a natural resources inventory and a forest stand delineation report for most development proposals. A plant species inventory identifies what species are present at the site, but it can also be used to determine what species might be absent or under-represented on the site. A planting plan featuring native plants should be part of a comprehensive landscape design that includes forest conservation, tree preservation, landscaping, and the creation of schoolyard habitat gardens. Landscaping with native species is not a substitute for preserving native forests and specimen trees. Before deciding where new plants should be located, decisions should be made about saving existing plants and, when possible, transplanting them. Careful planning will minimize destruction of native habitat. Typically, certain site areas are landscaped as part of schoolyard enhancement: the vehicular entrance to the site, pedestrian entrances to the building, courtyards, parking lots, drop-off areas, and the site perimeter. Plants with ornamental characteristics -- showy flowers, attractive fruit, colorful foliage, interesting bark, or handsome form -- are often used to frame or accent an entrance. Planting should be used to improve the microclimate by using large trees to shade the building, pedestrian pathways, play areas, roadways and parking lots. Planting may be used to deflect harsh northwest winds. The site perimeter may be planted to soften the view from the road or to screen the school from neighboring residential or commercial properties. Each situation offers an opportunity for adding native plants to the landscape treatment.

Site Planning Considerations

Native plant landscaping involves more than just preparing a planting plan as part of the construction drawings for a school site. Site planning decisions affect decisions about plant selection and planting design. Taking plant needs into account during the planning phase can help ensure healthier plantings and can make maintenance easier. The following are a few important practical recommendations that should be considered during the site planning process.

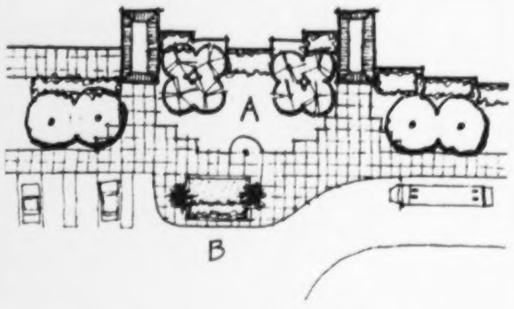
Orientation - Consider orientation during site planning and plant selection. Ornamental planting is often concentrated at the entrance to the building. An advantageous orientation for most plant materials is an eastern or southeastern facing site. Planting on the southeastern side of the building provides morning sun, shelter from harsh northwest winds, and protection from the hot drying western sun. Most plants, whether sun loving or shade tolerant, will adapt to this location. An east-southeast facing entrance is an ideal orientation for plantings, and it is also ideal for the activities associated with arrival at the school. The building is bathed in sunlight rather than hidden in shadow; the morning sun means that rain, ice or snow will begin to dry or melt faster. This is also the best orientation for a children's garden. The least desirable location for gardens and ornamental landscape plantings is the northwest side of the building. These areas are in the shade much of the year and subject to drying winds and hot late afternoon summer sun. Avoid placing major entrances to and exits from the building in these locations, particularly if doors remain open for extended periods as children move to and from outdoor play areas. Plantings at northern and northwestern sides of the building should be carefully selected for tolerance to climate conditions.

Water - Provide hose bibs as a source of water for planting areas. The area around the building will generally be hot due to radiant heat from the storage of the sun's energy in masonry walls, therefore evaporation of water from plants around the building is likely. If water is handy, it is much more likely that watering will occur.

Foundation Planting - Pay special attention to plantings immediately adjacent to the building. This is often the least desirable environment for planting. Large buildings do not need conventional "foundation plantings." They do not have foundations to conceal. Concentrate plantings in groups rather than in long lines all along a face of the building. In areas where there is no planting, consider providing a narrow paved mowing strip to make maintenance easier along the base of the building (See Figure 3 for an example of a mowing strip). Avoid creating narrow planting areas between the building and a pedestrian walkway, as these areas are subject to compaction during construction, dry out quickly, and suffer heat build-ups from the adjacent building.

Planters - Do not design small areas of planting within a large paved area. Plants that are surrounded by paving on multiple sides have a high likelihood of being trampled by students. As with narrow planting strips adjacent to the building foundation, these areas will suffer from the heat and compaction associated with the adjacent paving. Small planting "cutouts" within paved areas often have inadequate drainage and insufficient root space for good plant growth. Consider raised planters for ornamental plantings near the building entrance or in special pedestrian areas. The potential for trampling small shrubs and flowers will be reduced if plantings are raised above the level of the walkway. Planter heights can range from curb height (6 inches) to seating height (18 inches). The size of the planting area must be sufficient to support the growth habit of the plants within it. Larger is better.

FORMAL LANDSCAPE DESIGN



A Native plants can be used in designs with plants in rows or evenly spaced groupings.

B Raised planters reduce trampling of shrubs and flowers in pedestrian areas. They can be made seating height.

Figure 1

Planters are excellent areas for student planting projects to enhance the appearance of the school. Soil within planters is seldom subject to compaction by machines and it is easier to work the soil in planters than it is to excavate the soil near building or pathways (See Figure 1 for an example of a raised planter at a school entrance).

Circulation - Avoid using plants to control circulation. If a plant is in the way of a pedestrian route, it will not deter a student. The plant will get trampled. Thorny plants such as nonnative pyracantha or barberry are not a solution. They send a message (keep away or be hurt) that is inappropriate for a school environment. To define a special use area such as a playground or garden plot, and to keep traffic from cutting through, it may be necessary to build a low wall, fence, or berm. Plantings can make these features more attractive, but plants alone will seldom be enough to stop trespassers.

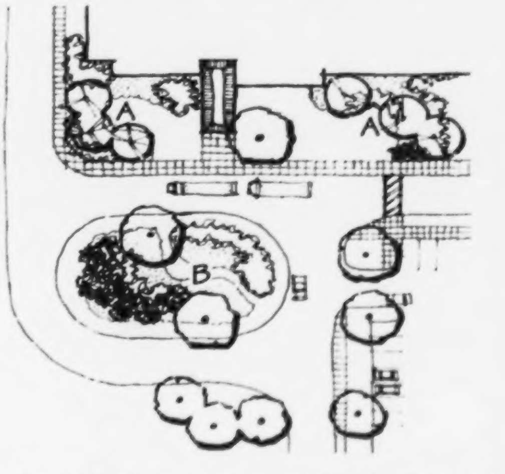
Storage - Provide storage areas for gardening and plant maintenance equipment. The storage should have access from outside of the building.

Landscape Design and Plant Selections

Selecting plants for a school site involves decisions about the visual characteristics of the plants (the artistry of design) and the adaptability of the plants to the site location (plant physiography). Designers seeking the right plant for the right place should make their selection based on the plant's form, color, or texture, and on the plant's place in the local ecosystem. Planting guides and nursery catalogues should be cross-referenced to determine if a plant is native or exotic (a plant from another country or another region of the United States), and to learn the wildlife benefits, ornamental characteristics, and cultural requirements of the plant being specified. As mentioned above, native plants contribute to the unity and harmony of the natural scene within any landscape. But the advantages of using native plants for ornamental landscaping go beyond their regional appropriateness. Native species provide a rich palette of plants with distinctive and desirable sensory characteristics. Prime examples include the multicolored shredded bark of the river birch, the lustrous leaves of the American holly, the delicate white flowers of the shadblow, the fragrance of the spicebush, and the profuse colorful berries of the nannyberry viburnum.

A commitment to using native plants in the landscape does not require that only native plants be specified. There may be cases when nonnative or cultivars of natives are selected for availability, design characteristics, or special site conditions. But a concerted effort should be made to include natives in the school plant palette.

NATURALISTIC LANDSCAPE DESIGN



A Choose plants that occur together in native communities, use staggered spacing and drift-like masses, and provide canopy and understory plants.

B A bus loop or large parking lot island can become a meadow, wetland, rain garden, or small ecosystem planting.

Figure 2

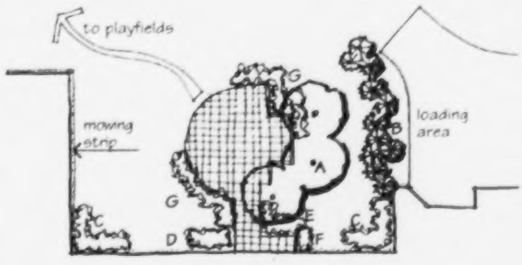
There are two different design approaches to incorporating native materials in a planting design: formal landscape design and naturalistic or ecosystem-based design. Both are valid approaches for the use of native plants on school sites (See Figures 1 and 2).

Native Plants and Formal Landscape Design - The first approach is to substitute native plants for some or all of the plants in a traditional design scheme. Formal rows, even spacing, or ordered groups of plantings may be appropriate to frame an entrance, define circulation through a parking lot or along a path, or create a strong geometry that echoes architectural massing. Native plants can be used effectively in such a design pattern.

Native Plants and Naturalistic Design - The second approach is to use native plants within a design structure that attempts to recreate plant communities or associations found in nature. A naturalistic or ecosystem approach usually employs staggered spacing and mixes species in drift-like plantings. In a plant scheme aimed at mimicking native communities, plants can be spaced closer together than is recommended in many textbooks or landscape ordinances. This close spacing would reduce the tendency to mow under and between trees and it would allow the plants to close their canopies to make an interconnected mass. A planting plan influenced by native assemblies would use plants in masses, locating them in places that approximate their natural habitat (upland, wetland, streamside, woodland, etc.).

Substitute Natives for Exotics - It is a relatively easy process to substitute native trees for exotic trees in a landscape palette (See Figure 3). There are numerous large shade trees and small ornamental trees suitable for Maryland sites that have ornamental qualities equal to those of nonnative trees. Most have handsome forms and foliage. However, a few native trees may have maintenance concerns that should be addressed. For example, the native sweetgum (*Liquidambar styraciflua*) with its handsome star-shaped leaf and multicolored fall foliage would be appropriate in a grove, as part of a wetland planting, or in a landscape buffer. However, the native sweetgum often produces a large crop of fruit capsules that could be undesirable on small islands in parking lots, near a storm drain, or along a driveway. A non-fruiting cultivar should be selected for such locations. Ash *(Fraxinus)* is a native

SUBSTITUTE NATIVES FOR EXOTICS



Key	As Planned	Possible Substitutes
A	3 Willow Oaks	3 Oaks
B	11 Japanese Black Pine	11 White/Loblolly Pine
C	24 Forsythia	24 Viburnum (mixed)
D	10 Yew	10 Bayberry
E	10 Sargent Juniper	10 Summersweet
F	2 Japanese Holly	2 Inkberry Holly
G	30 Cotoneaster	20 ea. Blackeyed Susan, Daisy, and Coneflower

Note: a 6" wide paved mowing strip located along the edge of the building can make maintenance easier.

Figure 3

species that tolerates dry or urban conditions. The native varieties produce seeds that have moderate wildlife value. The prolific seeds of this tree can propagate other trees and contribute to future forests. All too often a seedless variety is specified so that natural regeneration of the species cannot occur. Again, the maintenance issue will dictate whether the wild/native or the cultivar will be selected. In a parking lot, the seedless ash or a different native species may be recommended.

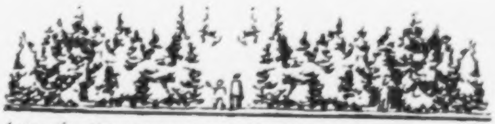
Using native shrubs provides a different landscape character than a planting design that features exotic or nonnative plants. Conventional ornamental plantings often rely heavily on exotic broadleaved and needle evergreen shrubs for a year-round green appearance. Certain frequently used exotic plants that are tough and hardy evergreens (junipers, yews, siebold euonymus, cherry laurel) have minimal seasonal change. Many of these nonnative plants have inconspicuous flowers, produce no fruit, and have little wildlife value. By contrast, many of our native shrubs are valued for their showy flowers, profuse fruit, colorful or interesting twigs, attractive fall foliage, and wildlife benefits. Most of the native shrubs suitable for schoolyard planting are deciduous and therefore change their characteristics with the seasons. A few natives are suitable as specimen plants, but most are best used in masses. Because many native deciduous shrubs are coarsely textured when they drop their leaves, a mixture of native and imported plants that includes evergreens or finely textured plants may be desirable for landscaped areas around the entrance to a school building.

Reforestation: The creation of a biological community dominated by trees and other woody plants containing at least 100 trees per acre with at least 50% of those trees having the potential of attaining a two inch or greater diameter within seven years.

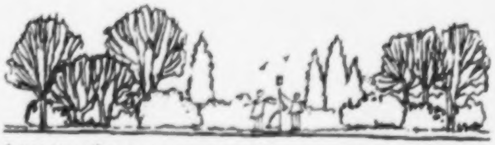
Afforestation: Establishment of a tree cover on an area from which it has always or very long been absent.

SITE PERIMETER OR BUFFER PLANTINGS

Native plants can be used to screen a road or neighboring property, or to deflect harsh northwest winter winds.



A row of native evergreen trees. Pure stands of trees occur in nature.



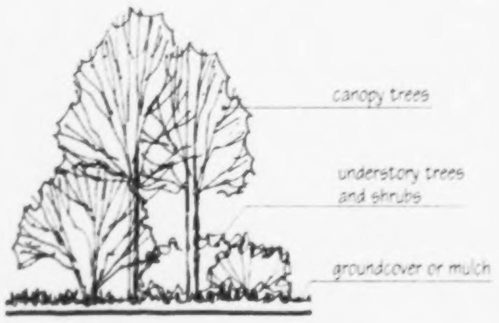
A hedgrow of evergreen and deciduous trees and shrubs. Many native plants provide food and cover for wildlife.

Figure 4

Perimeter or Buffer Plantings - Oftentimes a perimeter buffer is needed to screen the school from a road or from neighboring properties. Dense plantings also may be needed to buffer outdoor use areas from harsh northwest winter winds. The conventional planting solution might be a row of evergreen trees. A monoculture of a native evergreen is an acceptable solution; after all, pure stands do occur in nature. A more interesting approach would be planting a hedgerow. The hedgerow could be a mix of evergreen and deciduous material that emphasizes plants having fruits and nuts for wildlife. Deciduous plants can serve as effective buffers. Deciduous plants and their leaf litter have value for noise reduction and water protection. Planted closely together, hedgerows can provide dense screening in the summertime as many deciduous shrubs grow to a height of 12 feet in a few years. We are used to having more visibility into sites in the winter and accept, even enjoy, a peek into a hidden landscape once the trees have dropped their leaves (See Figure 4).

Native Plant Landscaping and the Forest Conservation Act - Many school construction projects are required to reforest or afforest the school site in compliance with the Maryland Forest Conservation

FOREST CONSERVATION LANDSCAPING



Landscape planting with native species may satisfy part of the reforestation or afforestation requirements of the Maryland Forest Conservation Act. Landscaped areas should be 2500 square feet or larger, a minimum of 35 feet wide, and planted with canopy and understory vegetation.

Figure 5

Act. Using naturalistic ecosystem-based landscape design may help satisfy the requirements of the forest conservation act. The forest conservation act allows certain kinds of landscaping to be counted toward the reforestation obligation for a site. Reforestation areas must be at least 2,500 square feet and 35 feet wide, and they need to have canopy, understory, and ground cover layers. In most cases grass is not considered an acceptable ground cover (See Figure 5). Thus, properly designed, a perimeter landscape planting could comply with the requirements of the Maryland Forest Conservation Act.

Site Suitability and Plant Selection

When selecting native trees and shrubs for school site landscaping, one approach is to look at a nearby forest to identify suitable species for planting. If the site conditions after construction of the new school are radically different from those of the adjacent area, this may not be the best approach. Massive grading to create level areas for a large building, playing fields, and extensive paved court areas may have severely disrupted the previous site conditions. Land that may have supported a native forest ecosystem has now been transformed into a very different landscape. The change to the soil is the most important factor affecting plant growth. Prior to development of the school site, the soil may have had the organic matter, pH, aeration, and moisture holding capacity needed for good forest growth. After construction, most sites are characterized as "urban soils" because the earth has been disturbed, mixed, excavated, or filled over. Urban soils often have a bulk density or compaction that far exceeds that of the site prior to construction. As a result, there is a lack of air in the soil, water will percolate through the soil much more slowly, and roots will have difficulty penetrating the soil. The pH of the soil is also affected by construction. The area around the building is usually the most severely disturbed. Building specifications usually call for a backfill of crushed gravel along the foundation wall. At many sites, construction debris finds its way into the backfill immediately adjacent to the building. These conditions, and leaching of the materials in the foundation slab, can contribute to an alkaline soil condition. Although most specifications call for stripping, stockpiling and re-spreading the existing topsoil of a site, this is seldom accomplished. After construction, most school sites have little, if any, topsoil or organic matter to provide the needed nutrients for plant growth. Thus, the site is no longer innately suited for the growth of many of the plants that previously inhabited the site.

For guidance about planting a site that has been severely disturbed by construction activities, we can look to sites that have undergone natural disturbances for clues to suitable plant use. A school site after development may have much in common with a site denuded by severe weather, pest infestation, or fire. Pioneer plants that invade a site after disturbance, or native plants that grow on dry open landscapes may be more appropriate than the species that made up the forest canopy and understory that once occurred on the site. Consequently, in cases where the site has been severely altered, it may be necessary to choose plants that are suitable to disturbed environments. Selection of plants that adapt to hostile environments should not be a substitute for preparing a site so that it will support healthy plant growth. Plants grown in compacted urban soils, even the most adaptable ones, will not grow as fast nor have as attractive a form as plants grown in a more suitable soil. Preparing the new site so that it will support the forest plants typical of the region is preferable to selecting plants that will have a better chance at surviving in an inhospitable environment.

BEST COPY AVAILABLE

Finally, plant selection must consider the cold hardiness of the plants. In Maryland, the Coastal Plain is in zone seven, the Piedmont region is in zone six, and the Appalachian Highlands in zone five.

Recommended Plant List

For successful school site planting, the plant palette should consist of species that are available from local suppliers, easy to establish, insect and disease resistant, have a high survival rate, and are tolerant of drought and compaction. The plants selected should have both wildlife and ornamental value. Appendix C is a list of plants that meet most of these criteria. The list is not a comprehensive compilation of native plants nor does it include hard-to-find or hard-to-establish plants. It focuses more on sun tolerant conditions, and therefore, it omits some forest plants that prefer the cool shady locations (hemlock, black gum, beech, hickories, azaleas, rhododendrons, mountain laurel). The strategy for schoolyard planting is very different from that for home landscaping. The flowering dogwood may be the most ornamental of our native understory trees, but it seldom survives or grows well at a school site unless it has good growing conditions (rich, well-drained soil) and adequate maintenance (watering, treatment for anthracnose). The list also avoids plants that may have high wildlife value but that may be messy, short lived, disease prone, or that may have poor form (black cherry, box elder). Many trees suitable for a reforestation planting will not be found on the list as it focuses on native plants for ornamental landscaping. The list does include trees and shrubs that are tolerant of wet soil or inundation, but it does not provide a comprehensive list of plants suitable for creating wetland, pond, or stream habitat areas. Plants are listed by moisture zones in the Wetland Section on page 46. Native perennial flowers and grasses should be considered an integral part of a school landscape planting scheme. The list only includes woody plant species, therefore other publications should be sought for recommendation of native perennial flowers and grasses. Perennials may be specified for new construction, but often they are planted as a part of schoolyard enhancement projects undertaken by parents or teachers who are committed to maintaining these plantings. Black-eyed Susan (the state flower), purple coneflower, and asters are a few reliable native perennials that do well for mass plantings in high visibility areas. All are suitable choices for planting during new construction.

Plants to Avoid

Invasive exotic materials are non-native plants that pose a threat to native plant communities because of their vigorous growth habit, prolific fruit, or because they may provide such dense shade that they prevent desirable native plants from germinating. Some of these undesirable plants appear on published lists of ornamental plants for landscaping. A list of exotic invasive species appears in the 1991, 1995, and 1998 editions of the Maryland Forest Conservation Manual. The list includes Norway maple, multiflora rose, honeysuckle (most species), autumn olive, Russian olive, Chinese privet, winged or burning bush euonymus, some buckthorn species, oriental bittersweet and many others.

Construction and Installation

Appropriate specifications for site preparation and plant installation area are essential to the success of any schoolyard planting. Soil specifications are as important as the selection of suitable plant material. If the soil is not prepared properly to support plant growth, plant survival and long term growth will be jeopardized. Specifications should include a requirement for soil testing. Landscaped areas should be aerated, organic matter should be tilled into the soil and the pH should be adjusted to the appropriate range prior to planting. The Landscape Contractors Association of Maryland, the District of Columbia, and Virginia publishes guidelines for site preparation, plant installation, and maintenance. These guidelines are an excellent model for the development of landscape specifications.

Long Term Maintenance

Native landscape plants, if chosen appropriately should require less maintenance than conventional ornamental landscaping. All plants benefit from watering at the time of installation and immediately thereafter. Large trees may require watering during dry periods for two years or more. But once established, native plants that are adapted to the regional and site conditions should be able to survive without supplemental watering and fertilizing. Maintenance can be further reduced by using a naturalistic or ecological-based planting scheme, where plants are massed in compatible groupings. Trees planted in groupings with understory plants or mulch beds will reduce the amount of mowing and trimming required. Landscapes of diverse trees and plants will also favor natural enemies to detrimental insects.

Cost

Landscaping with native plants will not be more expensive than landscaping with ornamental or exotic varieties. It is likely to be less expensive, particularly if native shrubs are substituted for exotic ones. Not only are deciduous plants less expensive than most ornamental evergreen shrubs, a deciduous plant is typically larger than a comparably priced evergreen shrub. When the leaves of a deciduous shrub drop in the fall, they add a natural mulch for that plant. Less watering and mulching may be needed. Native trees may be less expensive than named cultivars selected for their ornamental characteristics. Initially, a conventional plan that calls for trees in grass may be less expensive than an ecosystem planting that calls for a shrub or groundcover understory. However, in the long-run, maintenance costs may be lower for multilayered plantings. In addition, this type of multilayered planting may be developed as part of a forest conservation plan and thus be absorbed into the budget allocated to satisfy requirements of the Forest Conservation Act.

Student Participation

Initial school construction usually includes the design and installation of major tree and shrub masses and some landscape design associated with key site areas such as building entrances. The planning committee for a school construction project (see Chapter 2) will provide input into these landscaping decisions. Typically, however, school administrators, parent-teacher associations, community groups, and students continue the interest in planting efforts after the school has been occupied. Once the school becomes their own, students can participate in any phase of native plant landscaping from planning and design to installation and maintenance. The first step in the process might be an inventory of existing plants and plant communities on the site. By conducting a plant inventory, students can learn about plant and wildlife habitats on the school grounds. As a result, school groups may decide to undertake the creation of a meadow, wetland, or other site development option discussed in this manual. Students can develop schoolyard habitat projects, or they can enhance existing plantings by adding native ornamental shrubs and flowers to special schoolyard areas such as entrances, courtyards, or playgrounds. Projects such as adding perennial flower beds may require extra maintenance and should be undertaken only if school administrators and teachers support the effort, and if volunteers are willing to assume some responsibility for care. This care may involve weekly watering of flowers during periods of drought in the summer. By undertaking native plant landscaping projects, students learn about plant science, gain new skills, make their school more attractive, and come to understand how their actions can improve the environment.

RAIN GARDENS

Corkran Middle School Rain Garden
Anne Arundel County Public Schools

Case Study: Rain Gardens

More than 300 seventh graders at Corkran Middle School, Anne Arundel County, participated in a Service Learning Project to create the school's "Rain Garden." The project transformed an interior grassed courtyard into a beautifully landscaped stormwater treatment system that slows down, filters, and removes pollutants from runoff before entering the Chesapeake Bay.

The project was funded by a $1,000 grant from the Chesapeake Bay Trust with each student contributing more than 10 hours on the project. Art students were responsible for the design of the garden, while math students measured and made scale drawings. Language arts classes wrote articles for the school newspaper and social studies classes raised funds to build benches and bird houses. The science students were responsible for the majority of the labor: tilling the soil, planting the shrubs and wildflowers, spreading mulch, watering, and weeding.

The rain garden retrofit project was a cooperative effort with many participants including the Maryland Department of Natural Resources, Chesapeake Bay Trust, Save Our Streams, Prince George's County Department of Environmental Resources, Connector Corps, students, and faculty.

The project participants were honored and praised by local government and school officials, environmental groups, and environmentalists.

"You have created the first rain garden in Anne Arundel County, putting Corkran Middle School on the cutting edge of Bay restoration technology," said Ron Gardner of the Department of Natural Resources.

"You have contributed to the beautification of your school and the restoration of the Chesapeake Bay. You should be very proud," said Karina Shipps of the Connector Corps for Service Leaning.

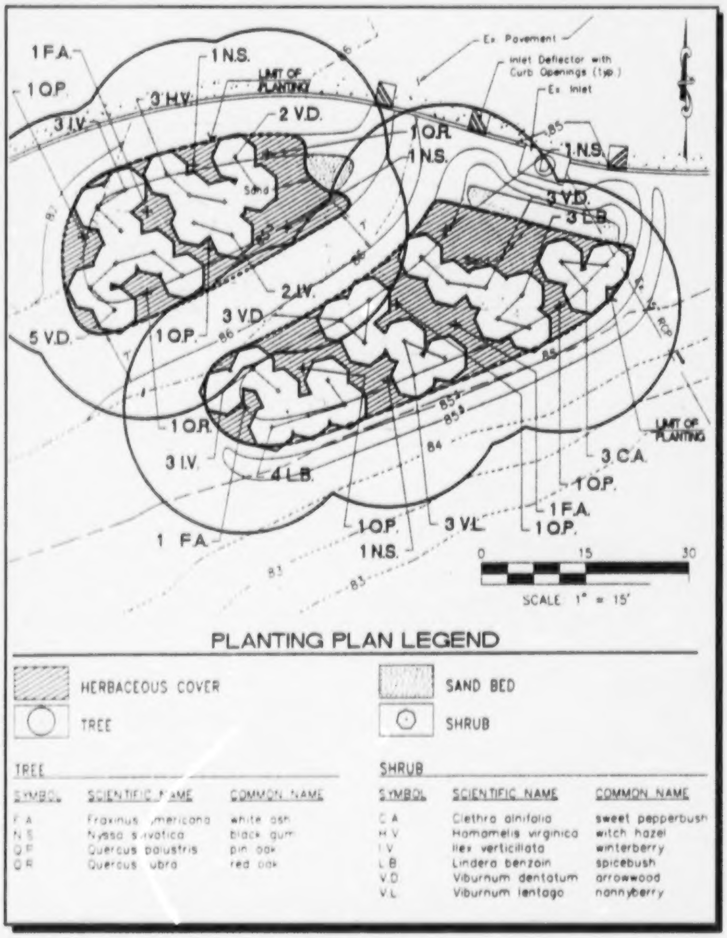
"It has been so encouraging to see the students accomplish this project with such interest and enthusiasm. It is amazing to see how much the students care about and take pride in the rain gardens that they created to protect the environment," said Peggy Sange, Corkran Middle School, Enrichment Teacher and Project Coordinator.

Rain gardens combine hydrologic and environmental benefits with the aesthetic and habitat values of landscaping. Depending on mitigation needs, type of application, plant materials, and site constraints, rain gardens can effectively remove pollutants from runoff, promote ground water recharge, restore watershed hydrology, enhance terrestrial habitat, provide shade to reduce thermal impacts, and improve aesthetics. Monitoring results have shown excellent pollutant removal rates of 60% to 80% for nutrients and 93% to 99% for heavy metals.

Environmental Enhancement

Rain gardens are simply very shallow (2" to 6" deep) landscaped stormwater runoff storage areas. Runoff is captured in these low lying areas to be infiltrated or filtered, allowing the soil and plants to uptake, transform, and remove pollutants. Rain gardens are not wetlands. They are designed to drain quickly allowing the use of typical landscape plants. The technique allows landscape and green space to be designed to serve many functions including stormwater management, aesthetics, habitat, and environmental protection. Using the landscape to treat stormwater runoff may reduce the need to use costly conventional stormwater management devices.

Rain gardens are designed using the principles of bioretention, a water quality practice in which plants and soil remove pollutants from stormwater. Bioretention is an alternative cost effective practice that allows the use of landscaped features to achieve runoff controls. Rain gardens are integrated into and uniformly distributed throughout a site's forested areas, green space, drainage swales, streetscapes, median strips, or parking lots. The term rain garden implies the use of bioretention measures in a highly visible area where a more aesthetically pleasing (garden like) design is desirable.



TREE

SYMBOL	SCIENTIFIC NAME	COMMON NAME
F.A.	Fraxinus americana	white ash
N.S.	Nyssa sylvatica	black gum
Q.P.	Quercus palustris	pin oak
Q.R.	Quercus rubra	red oak

SHRUB

SYMBOL	SCIENTIFIC NAME	COMMON NAME
C.A.	Clethra alnifolia	sweet pepperbush
H.V.	Hamamelis virginica	witch hazel
I.V.	Ilex verticillata	winterberry
L.B.	Lindera benzoin	spicebush
V.D.	Viburnum dentatum	arrowwood
V.L.	Viburnum lentago	nannyberry

Typical Planting Scheme for a Rain Garden Figure 6

BEST COPY AVAILABLE

Rain gardens are modeled after a terrestrial upland soil/forest composed of native upland trees, shrubs, and herbaceous plants. This system is not dependent on a constant source of water thereby reducing the need to destroy additional riparian forest or wetland areas by building conventional stormwater ponds.

Rain gardens maximize the use of physical, chemical, and biological pollutant removal processes to treat runoff. They are small models of natural forest ecological systems that demonstrate how the landscape functions to protect the integrity of a watershed's aquatic and riparian ecosystems. Their designs also demonstrate the interconnections of a wide array of environmental and engineering principles and disciplines including the hydrologic cycle, nutrient cycles, biology, forestry, soil chemistry, ecology, horticulture, and landscape architecture.

Planning, Design, and Construction

Key factors in the design and construction of rain gardens are careful selection of plant materials that can tolerate extreme hydrologic changes, good drainage to prevent creating anaerobic conditions, safe conveyance of overflows, careful use, inspection and control of backfill soils and careful inlet/outlet controls to prevent erosion.

Rain gardens consist of a shallow ponding area (6" deep or less), mulch layer, sandy planting soil, plant materials and, where appropriate, the use of under drains. The design can vary greatly to accommodate site constraints, ground water recharge, soils, habitat/ecological objectives, watershed hydrology, and aesthetics. The facility must be well drained by infiltration (where soils allow) or by under drains or both. Stored water runoff soaks into the ground over a period of less than a day into the underlying soils or to an under drain which discharges to a swale or pipe.

Specific configurations and locations of the rain gardens are determined after site constraints such as location of utilities, ground water level, steep slopes, underlying soils, existing vegetation, and drainage are considered. Where soil infiltration rates are lower than 1 inch/hour or in order to extend the life of the rain garden, under drains should be used to ensure good drainage.

The drainage area for one rain garden should generally be between 0.25 and 1 acre. Multiple rain gardens are needed for larger drainage areas. The storage volume of the rain garden will be determined by the desired level of control (e.g., first half inch of runoff) and de-watering capabilities of the design. Rain gardens work best when there are many facilities with small drainage areas. Large facilities with large drainage areas tend to allow soils to remain saturated for longer periods creating poor drainage conditions, stressing the plants, and reducing the pollutant removal effectiveness.

The maximum ponding depth of the bioretention area should be 6 inches. This depth provides for adequate storage and prevents excessive ponding periods. Water ponding for longer than three days restricts the type of plants that can be used and may encourage mosquitoes to breed.

A minimum planting soil depth of 2 feet is recommended. This depth will provide adequate soil for plant root systems and soil reactions to remove pollutants. Planting soil should be lightly compacted until the desired depth is reached.

Planting soil should be sandy loam, loamy sand, or loam texture and have clay content of 10 percent or less. The pH of the soil should be between 5.5 and 6.5. Pollutants (e.g., organic nitrogen and phosphorous) can be absorbed by the soil and microbial plant activity can flourish within this pH range. The planting soil should contain 3 to 5 percent organic content.

Native species of plants are recommended because they are tolerant to the regional climatic, soils and hydrology. The designer should assess aesthetics, site layout, habitat objectives, and maintenance requirements when selecting plant species.

After placing the trees and shrubs, the ground cover and/or mulch should be established. Ground cover such as grasses, legumes, or flowers can be used. Two or three inches of commercially available fine shredded hardwood mulch or shredded hardwood chips should be applied to provide erosion protection.

Specific Design Applications and Modifications

Rain gardens have a wide variety of applications. However, the designer must carefully consider the unique problems presented by each application.

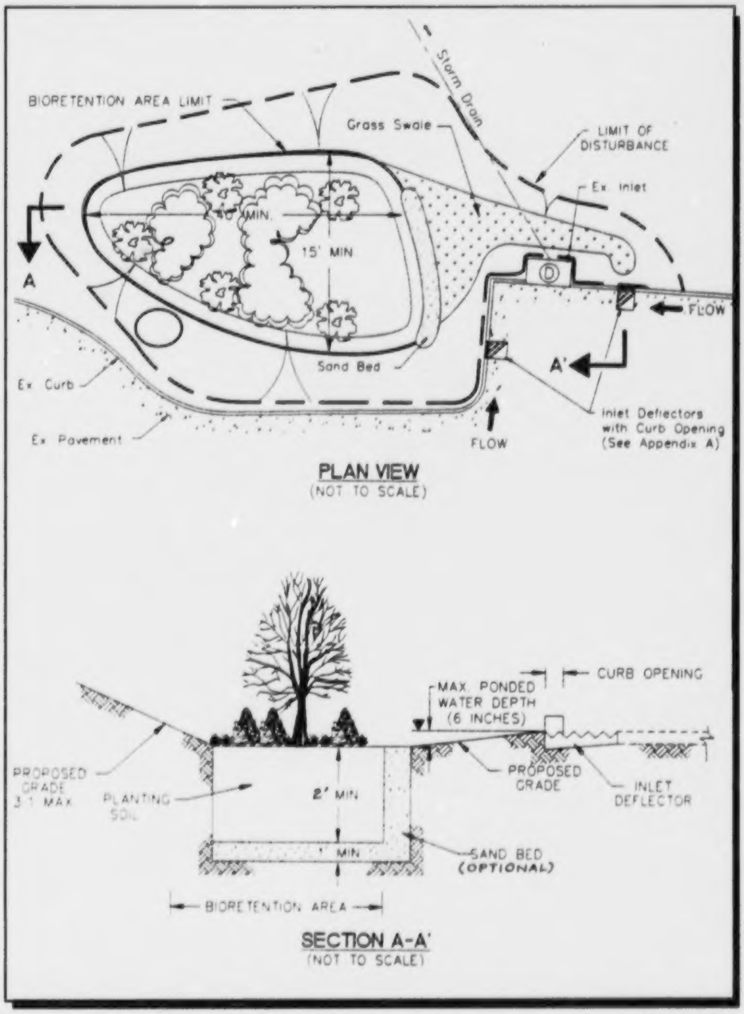
Parking Lot Islands, Median Strips, and Formal Landscape Islands Around Buildings - Care must be taken to ensure that infiltration and ground water seepage will not adversely affect the structural integrity of roadways or buildings. The careful attention to grading, location, and use of under drains can minimize these problems. It is important to divert rain garden overflows to inlets or grass areas in order to prevent deposits of sediment and debris onto parking surfaces.

Forested Areas - In some cases, existing forested areas can be converted to rain gardens by constructing small berms to allow no more than 2 to 4 inches of ponding water. Care must be taken to ensure the existing soils have high infiltration rates (1 inch/hr or higher) and can infiltrate the ponded water in less than 12 hours. Excessive ponding (greater than 24 hours) will adversely affect mature trees which are not tolerant of extreme changes in hydrology. Also, adequate measures must be taken to reduce the erosion potential of directing increased volumes and concentrated flows into existing forested areas.

Fringe Forest Areas - The rain garden can be used for re-vegetation of forest fringe areas to create a forest community and fringe habitat ecosystem. These areas would consist of trees, a sub-canopy of understory trees, a shrub layer, and ground covers. Plants can be selected for their habitat value (food, shelter, and nesting materials).

Open Space Meadows - Areas which are not used for recreation or other purposes can be designed as rain gardens. Where soils and topography allow, wild flower meadow basins can be constructed. Care must be taken to prevent erosion and to disperse flows throughout the bottom of the rain garden basin.

Open Swales - Rain gardens should not be used in the direct flow of an open swale. Since erosion may occur due to high velocities and concentrated flows, rain gardens can be used adjacent to a swale in an off line configuration.


BIORETENTION AREA LIMIT
Storm Drain
Grass Swale
LIMIT OF DISTURBANCE
Ex. Inlet
40' MIN.
15' MIN
D
A
A'
FLOW
FLOW
Sand Bed
Ex. Curb
Ex. Pavement
Inlet Deflectors with Curb Opening (See Appendix A)
PLAN VIEW
(NOT TO SCALE)
CURB OPENING
MAX. PONDED WATER DEPTH (6 INCHES)
PROPOSED GRADE 3:1 MAX
PLANTING SOIL
2' MIN
1' MIN
PROPOSED GRADE
INLET DEFLECTOR
SAND BED (OPTIONAL)
BIORETENTION AREA
SECTION A-A'
(NOT TO SCALE)

Parking Edge & Perimeter with Curb Figure 7

Landscape Trees - A simple application of a rain garden is to grade shallow depression storage areas around each individual tree. Careful selection of water tolerant trees can allow ponding depths of 2 to 3 inches extending in an 8 to 10 foot diameter around each tree.

Retrofit Existing Areas - Green space and landscaped areas can sometimes be converted to rain gardens. The most convenient areas to retrofit are near existing storm drain inlets. The area adjacent to an inlet can be regraded and landscaped to capture and treat runoff. A good example is the Corkran Middle School case study (page 22) where the courtyard drain was raised about 4 inches to create a shallow storage area around the inlet.

Limitations

Rain gardens relying on infiltration alone for dewatering should not be considered where the water table is within 4 feet of the ground surface and when the surrounding soils are unstable. The practice is also not recommended for areas with steep slopes greater than 25 percent or where mature tree removal will be required.

Long Term Maintenance

Rain gardens require routine periodic maintenance (e.g., mulching, plant replacement, pruning, and weeding) typical of any landscaped area. No special maintenance equipment is needed. Routine maintenance costs will increase proportionally to the number of plants used and area planted. The use of shallow depth under drains will reduce the chance of poor drainage due to clogging and the cost to excavate and replace soils and plant materials.

Cost

Rain garden costs are most attractive when compared to structural practices such as ponds. Cost savings over conventional stormwater practices can vary widely depending on unique site conditions. Savings of 10% to 25% over conventional practices have been achieved in the application of rain gardens to residential, commercial, and industrial sites. They do not require additional space as they are integrated into the existing landscape features. They require some additional costs related to the increased number of plantings, additional soil investigations and under drain systems. The use of meadow rain gardens to replace open space turf will have higher site preparation and plant materials costs but less long term maintenance costs than turf.

Student Participation

Rain gardens are easy to plan, design, and care for. Any of these aspects can be used to develop hands-on participation projects by students and school staff to retrofit schools grounds or to modify or care for existing rain gardens. Since they demonstrate a number of environmental principles, rain gardens are ideal for science studies and projects that demonstrate the hydrologic cycle, impacts of land use on the environment, and the creation of plant and wildlife habitat.

Regulatory Requirements

Regional landscaping and stormwater manuals should be consulted to ensure that the rain garden areas meet the landscaping and stormwater requirements established by the local authorities.

FORESTS

Choosing Plants
Sussex Elementary School
Baltimore County Public Schools

Case Study: Forests

Sussex Elementary School is located adjacent to Duck Creek in the Essex area of Baltimore County. Since 1990, teachers have been developing and implementing an environmental education program which has been successfully integrated into all areas of the curriculum. The project coordinator, Kathy Olver Brauer, says that the school staff has attempted to infuse environmental education into every facet of the students' school experience. Teachers have been provided with extensive staff development. The program emphasizes a hands-on approach, giving students not only information but also many opportunities for real world experiences.

An integral part of the program is the school's partnership with the Baltimore County Forestry Board. The board has assisted at nearly every step of the program by providing guidance, resources, and funding.

The project began in the Spring of 1990 with a Baltimore County Board of Education staff development grant of $500 to provide training on wetlands. In the summer of 1990, the Board of Education awarded the school with a teacher incentive grant of $12,000, for the Duck Creek Project. These funds provided staff development and materials related to wetlands and environmental education. In the spring of 1991, the Baltimore County Forestry Board made training available and provided trees and shrubs to plant along Duck Creek as a buffer zone.

Since 1991, teachers have developed and implemented a summer environmental education camp for elementary students. After-school programs have included environmental science, water monitoring, and schoolyard reforestation. Middle and high school students participate in these programs to earn service learning credits.

In 1991, the Chesapeake Bay Trust provided funding to produce a newsletter, *Duck Creek Quarterly*, on environmental education for teachers in Baltimore County. In 1994, the Trust provided funding for additional plantings in the buffer zone. Also, in 1994, the Chesapeake Bay Trust and the U.S. EPA provided funding to create an environmental telecommunication network for elementary schools. Training included: Save Our Streams, telecommunications, and the Baltimore County Forestry Board Schoolyard Reforestation Program. Participating schools were provided with telecommunication equipment, guides, and water quality testing materials. This aspect of the project was presented at a Maryland Association of Science Teachers annual meeting.

Planting along Duck Creek
Sussex Elementary School
Baltimore County Public Schools

In 1994, the Baltimore County Forestry Board and the National Tree Trust provided seedlings, potting soil, and pots to establish a schoolyard nursery. Students pot seedlings and allow them to grow for one year at which point they are planted in the creek buffer zone. In 1998, the Baltimore County Forestry Board provided trees and shrubs to expand the buffer zone along the creek. Planting involved students, teachers, and parents.

Planting along Duck Creek
Sussex Elementary School
Baltimore County Public Schools

Environmental education is an ongoing part of the curriculum at Sussex Elementary School. Additional activities have included garden projects, specialized staff development, development of a nature trail, water safety, hatching and releasing yellow perch, and water quality monitoring.

Environmental Enhancement

From the mountains to the Chesapeake Bay and the shores of the Atlantic Ocean, forests contribute greatly to the quality of life. Air quality is enhanced by forests which reduce atmospheric carbon dioxide through photosynthesis, filter particles, and absorb nitrates. Streams and associated aquatic life benefit from having forests anywhere in their watershed. Forests promote groundwater recharge as rain trickles through leaf litter into the ground. Clean, local groundwater is critical in maintaining stream water quality and a healthy balance of aquatic life. Forests moderate water temperature through shading and reduce the amount of sediment and other pollutants entering streams. Forests provide habitat for numerous plants and animals, and also provide recreational opportunities for people.

Regulations

Early in the 19th century, much of Maryland's forest cover had been cleared for agriculture or cut for fuel, timber, or charcoal. Currently, the loss of forest cover occurs primarily as a result of increased urban development. Unlike forest clearing for agriculture, clearing for development typically eliminates the regeneration potential of forests.

In 1990, the Governor's Task Force on Trees and Forests was created to assess the problems facing Maryland's trees and forests, identify solutions to these problems, and promote good land stewardship and protection. One recommendation was the creation of a forest conservation, protection, and reforestation law. The Maryland Forest Conservation Act subsequently was passed by the General Assembly in 1991 and most recently amended in 1997 and 1998 to conserve the State's forest resources during land development.

For all major school construction projects both new and renovations/additions, the requirements of the Maryland Forest Conservation Act and Regulations must be addressed. The Forest Conservation Act and Regulations (NRA Title 5 Subtitle 16 and COMAR Title 8 Subtitle 19) apply to any activity that requires an application for subdivision, grading, or sediment control permit on areas greater than 40,000 square feet. A forest stand delineation report and a forest conservation plan for the site must be submitted for approval to the Maryland Department of Natural Resources (MD DNR) Forest Conservation Program prior to permit approval. These plans are prepared by a Maryland licensed forester, Maryland licensed landscape architect, or other qualified professional. The forest stand delineation report includes an environmental features map as well as specific information on the existing forest and other natural features on the site. The forest conservation plan indicates the amount of forest disturbance, the methods to be used to protect the remaining forest, and the reforestation or afforestation required for the project. Planting must meet the stocking and survival requirements as stated in the regulations and must also have a two-year maintenance agreement that requires a percentage of the stock to survive for two years. Any planted or retained forest must have a long-term protective agreement that provides for the protection of the afforestation and reforestation areas. This protection allows for uses that are consistent with forest conservation, including recreation.

Planning, Design, and Construction

Conserving as much forest as possible on a construction site is an economical and environmentally sound practice. Temporary stormwater management during construction is lessened and permanent stormwater management requirements are reduced. Another benefit is that the more forest that is retained, the lower the forest mitigation requirement. For the forest remaining on a site, a forest stewardship plan can be developed by the county forester to meet the objectives for the forest. These objectives can include educational opportunities, wildlife habitat, safety, and income.

Some consider grass a less expensive alternative to planting trees. Grass costs less to plant than trees and may require less site preparation. However, grass will represent significantly greater long-term maintenance costs.

Compliance with the State Forest Conservation Program will require field work (a forest stand delineation report) and the preparation of an additional construction plan (a forest conservation plan). The forest stand delineation identifies the existing forest cover and environmental features on the proposed development site. The forest stand delineation plan should be completed prior to proceeding with the schematic design phase of a project. The forest conservation plan indicates the limits of disturbance for the proposed project, the mitigation planting plan, and how existing forested and sensitive areas will be protected during and after development. This plan is part of the site plan and construction bid package. It is submitted to the State Forest Conservation Program for review at the same time as the application for grading or sediment control permit is submitted for review to the appropriate agencies.

The planting of trees involves the purchase of planting material, some site preparation, and maintenance to ensure survivability. This work is usually part of the landscape/planting contract. A warranty is typically part of the contract and this covers the plants survivability for the first two years.

There are three types of planting stock readily available for school sites: seedlings, containerized, and ball and burlap. Seedlings are an average of 12 to 15 inches in height. Containerized plants are sold in pots. Ball and burlap are larger. It is recommended that the future use of the site be taken into account when determining the planting material. A mix of planting material is also recommended. Larger planting stock, ball and burlap, and containerized stock, can be located closer to high use areas while smaller material (seedlings) should be planted in the low use areas or behind the larger stock.

Site preparation and maintenance may be required, depending on the site. Site preparation may include, for example, disking and fertilizing the ground. Maintenance can include watering, pruning, and insect and disease control.

School Projects for Trees and Forests

Often schools are built on old farmland or a forest area that is cleared. Typically individual, widely spaced trees are then planted, which, although valuable, do not make the land considered forested. Forests are valuable because they not only provide food, shelter, and cover for many animals, but they reduce runoff by soaking up water and filtering out impurities, cool the air and recycle carbon dioxide back into oxygen. The forest floor, with its bed of leaves and plants, acts as a sponge to soak up rain. It also provides additional habitats because of the decay that is occurring there.

A variety of trees is important to an area because they provide for the different needs of the many animals that use them. Some trees produce seeds or nuts that are food for birds and squirrels. A large oak tree can provide enough acorns to feed many animals. Other trees produce a fleshy fruit used by birds and insects.

Trees of different sizes are necessary to create an overstory and understory in the planted forest. Some birds nest low to the ground while others will only nest high in the canopy. Birds of prey need tall trees for perching while other birds use the branches of smaller trees to hide.

There are many tree planting projects that may be helpful to conserve or enhance the natural environment of the school site. Among the projects that can be accomplished are:

Riparian Forest Buffer - Trees planted along streams are recognized as effective in protecting water quality. Forests filter sediment and control runoff. A stream buffer should extend a minimum of 25' plus four additional feet for each one percent of slope on either side of the stream.

Slope Plantings - Tree and shrub planting on slopes can be an effective means of reducing mowing and the potential for erosion.

School Forests - A selected area can be planted in seedlings or saplings. Subsequent outdoor activities may include the study of how trees grow and how factors such as insects, disease, and nutrient uptake influence tree survival and growth.

Forest Nursery - Seedlings are potted, grown, and cared for by students and staff until they are large enough to be transplanted. Contact Forestry Board or TREE-MENDOUS Maryland for information about seedlings, pots, and soils.

Screening/Shading - Trees can be planted to serve as a screen, suppress winds, add aesthetic value, or provide shade to a play area, building, or parking lot.

Chesapeake Bay School Reforestation Project

This program is designed to promote environmental protection and education through planting trees on school grounds. The goal of the project is for students and the school community to organize and implement the planting of a native forest to demonstrate its potential for improving the quality of the Chesapeake Bay, local streams and waterways, and wildlife habitat.

The project involves a broad spectrum of citizens through a cooperative effort of public school systems, County Forest Conservancy District Boards, the MD DNR Forest Service, local governments, and the private sector.

With direct student involvement, the school staff develops activities that integrate with school curriculum. Projects include an evaluation process and follow-up care and maintenance program demonstrating ownership and commitment to the planting site. The forester checks the sites periodically to provide advice on maintenance and management.

Local Forestry Boards select the projects to be considered for funding, then submit the project plans to the Executive Committee of the Maryland Association of Forest Conservancy District Boards. Grants are awarded to provide planting stock and materials which are ordered from local private nurseries or state nurseries.

Technical assistance is available from the MD DNR Forest Service. Foresters will assist in writing grant proposals and planting plans, and ordering planting stock and materials.

Forestry Boards have established more than 200 school forests under this project with sites in every Maryland county and Baltimore City.

Long Term Maintenance

Normally there is a one or two year plant survival warranty that is part of the planting contract. The State Forest Conservation Program requires a two-year maintenance agreement on the reforestation or afforestation planting plan as part of the forest conservation plan. If a planting contract includes a one year plant survival warranty, the school system is responsible for the second year of this requirement. For this reason, school systems should require a two-year plant survival warranty in the construction documents of a project. After this time period, the maintenance can be done by maintenance staff or students. Maintenance may include removal of the planting stakes and guy wires, yearly mulching, watering, pruning of dead limbs and branches, and insect and disease prevention.

Long term maintenance of planting areas or existing forested areas may be necessary to keep the forest healthy. A forest stewardship plan can be written that describes the necessary work and provides a timetable. The work may be done by students or professionals depending on the skill levels required.

Cost

Construction costs are dependent on the size of the site, the amount of forest disturbance, and the size of the reforestation or afforestation mitigation planting. The Forest Conservation Act allows for the removal of forests for development to a certain point before requiring reforestation to occur and requires afforestation if development occurs on a site without forests.

The costs involved in planting a school forest are dependent on plant material (size of material and species selected) and site preparation needed prior to planting. These costs will fluctuate based on the area of the state in which the planting site is located. The MD DNR Forest Service county forester will be able to assist with determining the planting material and site preparation needed prior to planting.

Seedlings can be purchased from the John S. Ayton State Forest Tree Nursery (1-800-TREESMD). Ordering must be done in late fall and the seedlings will be delivered in early spring. Seedlings are very reasonably priced and catalogs are available from the nursery.

Containerized plants can be purchased at most nurseries. Prices vary depending on container size, the nursery, and your location in the state. TREE-MENDOUS MD, a MD DNR Forest Service program, sells containerized trees and shrubs.

Ball and burlap plants can, like containerized plants, be purchased at any nursery. Prices vary depending on size, the nursery, and your location in the state. Generally ball and burlap plants cost more than containerized plants.

Preparation may be required for your planting site. This may include sod removal, tilling of the soil, and predigging holes for larger planting material. After the planting, post-planting site work will need to be done. This includes mulch and stakes. The costs for these items are variable and site dependent.

Student Participation

Students can, under the guidance of school staff, conduct site surveys and wildlife habitat assessments, write grants, develop schoolyard planting plans, and install and maintain the plants.

Site surveys require the students to inventory the existing site conditions and develop a map that reflects the information. This information is used to develop a school forest plan. With this information, a forest stewardship plan can be developed which guides the management of the forest to meet the objectives of the school. Objectives can range from wildlife habitat to creating access to study areas. The students can develop planting plans and plant material lists, and install and maintain plant material. Maintenance can include watering, nesting box care, pruning, filling bird feeders, and conducting structural repairs. In order to pay for the planting material, the students can apply for grants. Students can also write news releases about their projects.

Safety

As part of the forest stand delineation report, existing forest is evaluated to determine its ability to withstand and survive the proposed construction activity and future use of the property. Individual trees are also evaluated to determine if they pose a risk to construction workers or subsequent property users. Those areas considered at risk or that pose a risk to people may be targeted, when practical, as the area to be developed or for selected tree removal.

If there is a question about the safety associated with one or more trees on a school site, the regional forester should be contacted for an evaluation of the problem. The Forest Service will evaluate the situation and give recommendations on the proper action.

Planted areas, if designed and planted without safety in mind, can become a security issue. In areas where visibility is a priority, certain trees such as rows of conifers should not be planted. Deciduous trees and shrubs should be planted instead. Plant material can also be pruned to allow easier visibility. The MD DNR Forest Service can give recommendations on tree species and correct pruning techniques.

Riparian Forest Buffer
Eden Mill Nature Center

MEADOWS

Measuring Meadow to Determine Quantity of Seed
Hollywood Elementary School
St. Mary's County Public Schools

Case Study: Meadows

In the Spring of 1996, Hollywood Elementary School students (St. Mary's County) in first grade through fifth grade were involved in converting approximately 1/4 acre of lawn on the school site to a wildflower meadow. The students in each of the classes participated in various pre- and post-investigations, in addition to planting a section of the meadow. Technical support for the project was provided by Rich Mason of the U.S. Fish and Wildlife Service and Mary Piotrowski, naturalist and school volunteer.

Several pre-planting investigations were part of the meadow project:

- Conducted a Wildlife Habitat Comparison of an existing meadow (old farm field) and a mowed lawn. Using hula hoops to select random sample areas in the meadow and the lawn, the students compared plant diversity, food sources, cover, and evidence of wildlife.

- Compared survival rates of tricolor pasta which represented "camouflaged prey" in the meadow and in the lawn. Students acted as predators and searched for the "prey" in each habitat to draw conclusions about which habitat provided better cover for the "pasta animals," and which color animal was better adapted to each respective habitat.

- Researched the amount of pollution generated by the lawn mowers used to mow the lawn, and how much money would be saved by converting the area to a meadow.

- Observed the sun's movement across the planting area. Students made drawings of the area at times throughout the day to record the amount of sunlight and shade reaching different parts of the area.

- Tested the soil to determine how compacted the soil is and how well it drains.

- Used trundel wheels to measure the planting site. Students then calculated the area of the site.

- Calculated the amount of seed needed. Approximately 5 lbs of seed was used per acre.

- Compared the composition of the two seed mixes used. Students used a Venn diagram to show which seeds were common to both mixes and which seeds were present in only one of the mixes.

- Researched what kinds of birds, butterflies, and other animals will be attracted to the plants listed in the seed mixes.

Raking Soil in Preparation for Hand Broadcasting Seed
Hollywood Elementary School
St. Mary's County Public Schools

Two different seed mixes were used. The U.S. Fish and Wildlife Service provided one mix and the P.T.A. purchased a different variety. One mix was planted in one half of the planting area and the other mix in the other half. After two years, there does not appear to be a significant difference between the two mixes. Some of the seed mix was reserved to plant in bare spots the following Fall. The seed mixes were still viable after one to two years of storage in the refrigerator. To make it easier for the children to broadcast the seed, seed was mixed with sand. The sand acted as a carrier, making it possible to spread the seed more evenly. In addition, because the sand was a different color than the soil, the children were able to see where they had spread the seed.

After eradicating the existing lawn, a local farmer tilled the area with a tractor. The area was divided into eight sections. Students in two classrooms were responsible for one section. The students began raking to loosen the soil. The sections that had been raked more had better success.

Naturalist Mary Piotrowski worked with each of the classes as they planted. The students used the following procedure:

- Rake the soil.
- Practice broadcasting sand without seed in a non-planting area.
- Broadcast the seed ("Feed the chickens").
- Rake the seed into the soil.
- Stomp the area with your feet (Do the "Meadow March").
- Spread straw over the area.
- Water with a sprinkler.

Several post-planting investigations were conducted:

- Writing letters to another school to explain the benefits of planting a meadow and the method used.
- Monitoring the growth of the meadow.
- Keeping a log of the wildlife that visits and inhabits the meadow.
- Putting socks over the students' shoes to collect and observe seeds.
- Making observational drawings of the wildflowers and using field guides to identify them.

The meadow requires very little maintenance. The meadow is mowed once a year in the Fall to disperse the seeds and to maintain it as a meadow.

The school staff is very pleased with the success of the Meadow Planting Project. The project continues to benefit the students each year by enabling them to experience and interact with the meadow firsthand, and understand the importance of the meadow ecosystems and its connectedness to other ecosystems. Converting an area of unused lawn to meadow has increased its habitat value for wildlife and its educational value for the students.

Environmental Enhancement

A meadow is a grassland with a mixture of wildflowers and native grasses. In the eastern United States where moisture is abundant, meadows are usually temporary and, if left alone, will succeed into a woodland. Historically, there were more meadows in the East than there are today as fires set by lightening and Native Americans kept trees out of certain areas and allowed meadows to thrive. Grazing by animals that once existed in the East, including elk and bison, also helped perpetuate Eastern grasslands.

Meadows provide a unique habitat for a variety of plants and animals. Native grasses form the primary structure of meadows. Unlike the turf forming nature of lawn grasses, many of the native grasses grow in bunches. The bunch forming habit creates nesting spaces and travel corridors for a variety of birds including bobwhite quail, bobolinks, meadowlarks, ground nesting sparrows and many other birds. Rabbits, voles and other small animals take advantage of this bunch-like structure. The wildflower or forb component of meadows provide additional structure but more importantly provide nectar and seeds for birds, mammals and many insects. Insects are vitally important as they are at the base of the Earth's food web and provide the free service of pollination. A variety of fascinating butterflies abound in meadows. Predators including hawks and foxes are attracted to the abundance of prey species in meadows.

Meadows, like forests and wetlands, provide protection to streams and, ultimately, the Chesapeake Bay as the thick vegetation allows rainwater to slowly percolate into the ground filtering out pollution. Recharged groundwater delivers cool, clean water to streams.

Restoring grasslands is a high priority to biologists as the acreage of this habitat has dwindled to a critical level. Only one percent of the original prairie remains of the huge grassland that once stretched from the Ohio Valley to the Rocky Mountains. Acreage of Eastern grasslands are also at an all time low.

Contribution to Educational Programs

Once a meadow is established there are many hands-on instructional activities that can be developed. A meadow is a rich resource for students. Younger students can use the meadow to visualize and describe colors, shapes, textures, and smells. Children can learn to write, spell, and read words and sentences related to the meadow. Leaves, flower petals, seeds, and insects can be used to teach introductory mathematics. Older students can keep a journal about the meadow through the entire year making observations and entries once a week. From their journal entries, students can develop an information fact sheet about the meadow, complete a creative writing task or develop a play or skit about some aspect of the meadow. World geography can be learned by mapping grassland habitats around the world. A wealth of science investigations that also incorporate mathematics and language arts can be taught using the meadow. Habitats, birds, plants, insects, pollination, soil, water cycle, and photosynthesis, are just a few of the many science topics that can be taught using a meadow.

Planning, Design, and Construction

Most areas on a school site not designated for a specific use are typically seeded in turf-grass. These areas are excellent candidates for meadow establishment. Meadows can be planted over septic drainfields as a low maintenance option to turf. An ideal place to establish a meadow is on embankments including those within stormwater management ponds. The National Resource Conservation Service has seed mixes for embankments (See Table 3).

DAMS AND SPILLWAY	
Creeping Red Fescus (Festuca rubra)	25 lbs/acre
Chewing Fescue (Festuca rubra ssp. Falax)	25 lbs/acre
Hard Fescue (Festuca trachphylia)	25 lbs/acre
White Clover (Trifolim repens)	25 lbs/acre
Oats or Barley should be added for quick soil stabilization	20-40 lbs/acre
OTHER SLOPES OR EMBANKMENTS	
Any warm season grass/wildflower mix including the three mixes in Table 4. Add 20-40 lbs/acre of oats or barley for quick soil stabilization.	

Seedmixes for Dams/Spillways and Embankments Table 3
(Natural Resource Conservation Service)

On existing school sites, proper ground preparation is critical for desired results. Turf-grass and weeds are very aggressive and should be removed.

The size of the meadow is related to available space. A meadow can range from a 100 sq. ft. meadow garden to several acres. A large meadow will provide many more environmental benefits than a smaller one. When designing the shape of the meadow, plan for gentle curves as opposed to straight lines. Mowed trails should be an integral part of larger meadows.

A commonly asked questions is, "Can we let the lawn grass grow to establish a meadow." The answer is yes; however, turf grasses and weeds that make up school lawns will not develop into a colorful and interesting meadow of native plants. If the area is to be managed as a meadow, then it is best to remove existing turf and weeds, and plant meadow seeds or plants. However, if the long term plan is to allow the area to evolve into a woodland then the lawn grass can be left to grow. Grasses and weeds will eventually give way to colonizing tree seedlings as a young forest develops.

Site Selection

A meadow can be planted almost anywhere that has at least 6 hours of sunlight during the growing season. If plants (including grass) are already growing on the potential site, it is likely the soil is suitable for meadow establishment. Be aware that tall meadow grasses can block the vision of motorists near intersections and bus travel lanes.

After the site is selected, gather information about the growing conditions that include sunlight, soil texture, and soil moisture. This information will allow selection of an appropriate species mix.

Sunlight - A minimum of 6 hours of sunlight is needed for meadow plants.

Soil Texture - Determine if the soil texture is *clayey*, *sandy* or an intermediate soil texture called *loam*.

Moisture - Decide if the site is wet (puddles remain for several days or weeks after hard rains), very well drained (puddles do not form after rain) or moderately well drained (average soil drainage). Soil moisture in most situations is directly related to the soil texture. For example, clay soils are generally wetter since they drain slowly and sandy soils are generally dry since they drain quickly.

Note: To have your soil professionally evaluated, bring a sample to your local Soil Conservation District Office or send a sample to the Cooperative Extension Service (see Appendix B).

Plant Selection

It is important to select species that are adapted to the soil and moisture conditions of the site. Locally native plant species should be used as these are best adapted to local climate and soil conditions. Be cautious of mixes in seed catalogs called "Northeast or Southeast Mix" as these usually only contain a few plants native to the region. Students can research and develop their own mix using seed catalogs or site information can be given to a seed supplier to develop a mix.

A good mix contains 50% perennial wildflowers and 50% native grasses. A cover crop of oats and barley at 20-40 lbs/acre should be used on sites with exposed soil to prevent erosion. A cover crop is not needed in no-till applications (see discussion of mechanical seed drill method on page 39). Most perennial wildflowers will take 2-3 growing seasons before blooming. Seeds planted in the spring will begin to bloom the following spring or later. Patience is important.

For sites less than 1,000 sq. ft. plants are often used although seeds can be used. Plants will give quicker results. For larger sites, seeds should be used. For larger seeded sites, the seeded area can be supplemented with plants. Plants will provide blooms the first growing season.

Recommended seeding rates vary widely from between 6 and 15 pounds per acre. When ordering seeds, inquire about the optimum rate for your site. If using plants, space on 2′ centers.

Ground Preparation and Seeding Method

Hand broadcasting seed and using a mechanical seed drill are the two seeding methods outlined. Several ground preparation approaches are provided depending on the size of the project. Select the ground preparation option that best fits the needs of the project and be diligent about completing the recommended steps. The best success is achieved with thorough ground preparation.

Planting a meadow on a new construction site is less difficult than an existing site where turf must be removed. There are a few basic tips to follow for newly graded sites. Topsoil should be saved and spread across the site. Do not use fertilizer as meadow plants are adapted to low fertility soils and fertilizers promote weed growth. Do not use lime as this also encourages weeds. Use the hand broadcast or mechanical seed drill method (see following discussion). When hand broadcasting, roll the site after seeding to ensure good seed to soil contact. When using the mechanical seed drill, firmly pack the seed bed before seeding. Hydro-seeding is not recommended as results have not been satisfactory. At the same time the meadow is planted, spread 20-40 lbs/acre of oats or barley seed for quick cover to stabilize the soil. Finally, lightly cover the site with a clean straw mulch.

On existing school sites, turf must be diligently removed before seeding is done. Several methods are explored in the following discussion.

The seeding recommendations that follow recognize that wildflower seeds germinate better when planted in the fall and that grass seeds germinate better when planted in the spring.

Hand Broadcasting - Hand broadcasting seed is feasible on sites up to an acre. Depending on the size of the meadow, equipment needed for ground preparation varies from shovels and rakes to a disc pulled behind a tractor. More ground preparation steps are involved with this method compared to using a mechanical seed drill. An option for larger areas is to divide the site into smaller sections and complete one section each year by hand broadcasting. The benefit to this approach is that many students can be involved over time. Students can collect seeds from established sections to plant the next section.

GROUND PREPARATION FOR HAND BROADCASTING SMALL SITES WITH EXISTING TURF:

OPTION 1:

June - August
Remove the sod by using a sod cutting machine. Be sure to remove all the roots of the grass. A sod cutting machine can be rented from a tool rental store. Next, lightly till or rake the soil. Water the soil to stimulate the germination of dormant weed seeds. Wait for two weeks of warm weather to allow dormant weeds to germinate. Roto-till or disc the site one to three times waiting two to three weeks between each tilling.

October - November
Plant approximately 3/4 of the wildflower seed and 1/4 of the grass seed following the instructions for hand broadcasting (page 39).

April
Plant approximately 1/4 of the wildflower seed and 3/4 of the grass seed following the instructions for hand broadcasting.

OPTION 2:

March - May
Remove the sod and cover the site with black plastic. Cover with mulch to hold the plastic in place. This process should kill any remaining weeds or grass.

October - November
Remove the plastic. Plant approximately 3/4 of the wildflower seed and 1/4 of the grass seed following the instructions for hand broadcasting.

April
Plant approximately 1/4 of the wildflower seed and 3/4 of the grass seed following the instructions for hand broadcasting.

GROUND PREPARATION FOR LARGE SITES WITH EXISTING TURF:

April - September
Remove the sod with donated or rented equipment. Roto-till or disc the site several times waiting 2-3 weeks between each tilling. Each time more grass and weeds will be removed.

October - November
If the seed bed appears to be mostly weed free two weeks after the last tilling, plant approximately 3/4 of the wildflower seed and 1/4 of the grass seed following the instructions for hand broadcasting.

April - May
Plant approximately 1/4 of the wildflower seed and 3/4 of the grass seed following the instructions for hand broadcasting.

Sample Meadow Mixes for the Mid-Atlantic

The following are three mixes containing species native to Maryland that are available from seed suppliers. The mixes give a range of bloom colors that will be present from late May to October. The lists are provided as a general guideline. Most seed suppliers have ecologists that can be very helpful in developing seed mixes to meet specific needs.

DRY SOIL (mostly sandy to loamy)

FLOWERS

Butterfly Milkweed (Asclepias tuberosa)
Common Milkweed (Asclepias syriaca)
Heath Aster (Aster ericoides)
Partridge Pea (Cassia fasiculata)
Showy Tick Trefoil (Desmodium canadense)
Purple Coneflower (Echinacea purpurea)
Wild Blue Lupine (Lupinnis perennis)
Wild Bergamot (Monarda fistulosa)
Black-Eyed-Susan (Rudbeckia hirta)
Gray Goldenrod (Solidago nemoralis)

GRASSES

Little Bluestem (Schizachyrium Scoparium)
Indiangrass (Sorghastrum nutans)
Canada Wild Rye (Elymus canadensis)

MEDIUM SOIL (loam to silty clay loam)

FLOWERS

Butterfly Milkweed (Asclepias tuberosa)
Common Milkweed (Asclepias syriaca)
New England Aster (Aster novae-angliae)
Zig-Zag Aster (Aster prenanthoides)
Flat-Toped White Aster (Aster umbellatus)
Showy Tick Trefoil (Desmodium canadense)
Purple Coneflower (Echinacea purpurea)
Wild Blue Lupine (Lupinnis perennis)
Wild Bergamot (Monarda fistulosa)
Black-Eyed-Susan (Rudbeckia hirta)
Stiff Goldenrod (Solidago rigida)
Hoary Vervain (Verbena stricta)

GRASSES

Little Bluestem (Schizachyrium Scoparium)
Canada Wild Rye (Elymus canadensis)
Indiangrass (Sorghastrum nutans)

WET SOIL (typically high clay content)

FLOWERS

Swamp Milkweed (Asclepias incarnata)
New York Aser (Aster novi-belgii)
Nodding Bur Marigold (Bidens cernua)
Joe-Pye Weed (Eupatorium fisulosum)
Spotted Joe-Pye Weed (Eupatorium maculatum)
Boneset (Eupatorium perfoliatum)
Rough-Leaved Goldenrod (Solidago patula)
Blue Bervain (Verbena hastata)
Ironweed (Vernonia fasciculata)

GRASSES

Big Bluestem (Andropogon gerardii)
Eastern Gama Grass (Tripsacum dactyloides)
Switchgrass (Panicum vergatum)
Fox Sedge (Carex vulpinoidea)
Soft Rush (Juncus effusus)
Sensitive Fern (Onoclea sensibilis)

Table 4

STEPS FOR HAND BROADCASTING SEED:

1. To ensure even distribution of seed, mix seed with 3-5 parts moist sand, sawdust or peat moss medium. Moisten the medium to allow the seed to stick.

2. To ensure good coverage, use 1/2 the mix and spread evenly in one direction then spread the other half walking perpendicular to the first pass.

3. Lightly rake or drag a piece of chain link fence across the soil to ensure good soil to seed contact.

4. Compress the soil to ensure soil to seed contact by rolling, having children stomp throughout the entire site, or drive over site with a vehicle.

5. Seed germination is increased if straw mulch is lightly spread across the site. The straw keeps soil moist allowing for better seed germination.

6. The options above recommend planting in the fall and early spring. If planting in late spring or early summer, watering can enhance germination.

Combination Mechanical Seed Drill/Hand Broadcasting Methods - Establishing a meadow using a mechanical seed drill is a simple and effective method. The mechanical seed drill method is generally used only on large sites since the drill is pulled behind a tractor. Special mechanical seed drills must be used due to the fluffy nature of the native grass seeds. Several drills (referred to as Truax or warm season grass drills) are available for loan through the Maryland Department of Natural Resources, Soil Conservation Service or National Wildlife Refuges. Some landscape contractors have the special drill and can be hired to prepare the ground and plant the meadow. If assistance is planned from volunteers such as a local farmer, an experienced person from a natural resource agency or contractor should be on hand to supervise the seeding. If a local farmer agrees to help, make sure the hydraulic connection is compatible between the tractor and drill.

If a mechanical seed drill is used, some seeding should be reserved for students to plant using hand broadcasting. This allows students to be involved in the planting.

GROUND PREPARATION:

April - September
Roto-till or disc the site several times waiting two to three weeks between each tilling. Each time more grass and weeds will be removed.

October - November
Roll the site to create a firm seed bed then plant 1/2 of the wildflower seed with students using the hand broadcasting method.

April - May
Using the mechanical seed drill, plant the remainder of wildflower and all of the grass seed.

Long Term Maintenance

A yearly maintenance plan needs to be developed with the grounds supervisor. A mower or bush-hog that can adjust to a height of 6'' - 8'' is needed for proper maintenance.

The first year requires special attention to reduce weeds. Remove weeds by hand on small sites. For large sites, mow to a height of 6'' - 8'' every six weeks. Mowing eliminates annual weeds before going to seed and will not harm new wildflower seedlings and native grasses. If weeds are not evident, mowing is not necessary.

Beyond the first year, annual mowing is needed. Divide the meadow into two or three sections. Mow one section each year on a rotation before April 1st or after August 31st to avoid the nesting season of small mammals and ground nesting birds. An optional mowing schedule to allow the most cover for wildlife is to mow 1/3 of the site every March. Mowing only a section each year allows cover for wildlife to remain at all times. Butterfly and other insect larvae will survive in the uncut portion. For cutting small sites, a weed whacker or scythe can be used.

After mowing, remove cut material and thatch to sustain the meadow. This practice opens the soil to light promoting the growth of new meadow plants. Removing thatch can be done with a hand rake on small sites or a mechanical rake pulled behind a tractor on large sites. A second method to remove thatch is a controlled burn. Fire is used by grassland managers as a very effective method to remove thatch, remove woody species, and promote new growth. In the Midwest, where prairie restoration has been underway since 1970, burning is an accepted and necessary management practice even on school grounds. Strict precautions are necessary if burning is done on school grounds. Contact your local fire department or a specialist from the Maryland Department of Natural Resources to oversee a controlled burn.

Cost

In addition to the environmental benefits, there is a significant economic incentive to transforming unused turf areas into meadow. Once a meadow is established, mowing is done once a year for a portion of the meadow as opposed to 12-15 times a year for an entire lawn. Along roadsides, through power line right-of-ways and on corporate commons, meadows are established to significantly reduce maintenance costs while providing an excellent environmental benefit. School systems can also benefit from this landscape practice.

The seed cost for a meadow can range from $400 - $1,200 an acre depending on seed source, seed quantity, and species mix. Seed companies can tailor a mix to your budget.

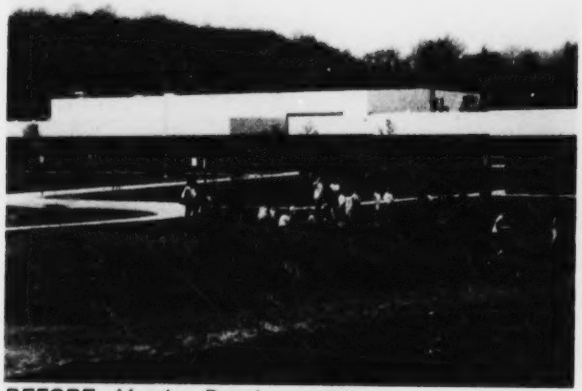
Student Participation

There are many opportunities for students to be part of the planning, design, and planting of a meadow. Their involvement depends on the method that is used to establish the meadow. At the very least students can:

- Measure, plot, map, and calculate the size of the meadow.
- Determine how many pounds of seeds are needed based on the area.
- Determine if the soil is sandy, loamy or clay, how moist the site is, and use this information to research and select species from a seed catalog.
- Contact community members for assistance with tilling, seed drills, etc.
- Apply for a grant.
- Hand broadcast the seed.
- Monitor seed germination.

Safety

Ticks are a concern with tall grasses. Students should not wade through the meadow. Mowed trails should be used for access. Students should check for ticks each time the meadow is used and parents should be aware of the possibility that their children may pick up ticks.



BEFORE: ***Meadow Development***
Seven Oaks Elementary School
Baltimore County Public Schools

AFTER: ***Completed Meadow***
Seven Oaks Elementary School
Baltimore County Public Schools

WETLANDS

BEFORE: *Wetland Development*
Bohemia Manor Middle School
Cecil County Public Schools

AFTER: *Completed Wetland*
Bohemia Manor Middle School
Cecil County Public Schools

Case Study: Wetlands

A wetland project at Bohemia Manor Middle School in Cecil County was developed from the vision of the 6th grade teaching team. In September 1997, three members of the team attended a workshop given by Environmental Concern, Inc. in St. Michaels, Maryland where they learned how to select and propagate plants for wetlands. With the encouragement and assistance of Rich Mason of the U.S. Fish and Wildlife Service and Laurissa Heller from the Chesapeake Bay Trust they began to plan. A site behind the middle school was selected.

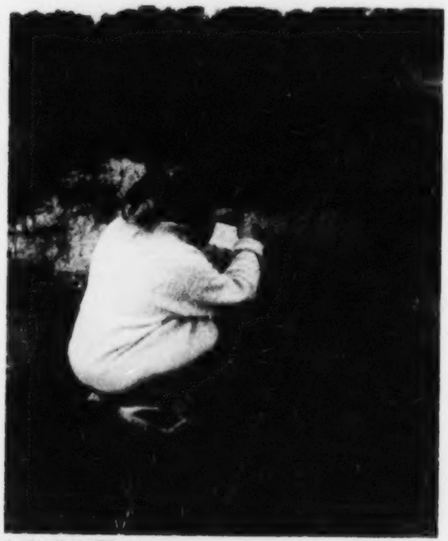
In early January, 1998 one of the team members attended a grant writing workshop. Charlie Hayes and Bill Metcalf of the Cecil Soil Conservation District offered their assistance. The first planning meeting was held in late January, 1998. The Cecil Soil Conservation District agreed to prepare a plan including wetland planting zones, and an observation platform. During the winter months, the team discussed what lessons could be taught using the wetlands as the vehicle.

In math, students drew maps of the proposed wetland and calculated the area of the wetland. In reading, magazines called *Wetlands* were ordered from Kids Discovery. Students read, made bumper stickers, video tapes, and became very knowledgeable about wetlands and their importance to the environment.

With their new knowledge, the science students selected the plants for each wetland zone, and math classes computed the number of plants for each zone and calculated the total cost.

Social studies classes mapped wetlands all over the world and learned the economic and geographical implications and importance of wetlands. In English class, students used what they learned to write a grant to the Chesapeake Bay Trust and letters to local businesses requesting contributions.

Excavation of the wetland began during spring break. When the students returned to school, the wetland was holding water. There were many community people and businesses involved in providing funding,



Labeling Plants
Bohemia Manor Middle School
Cecil County Public Schools

equipment, materials, and labor. A grant for about $900.00 was received from the Chesapeake Bay Trust and used to order plants. A small portion of the grant money was spent for two substitute teachers and on May 19, 1998, 153 6th grade students planted plants in shifts. Rich Mason gave students instruction and was there to answer questions. Local community supporters were there all day.

The wetlands project was a great success. The project helped the environment, taught students and teachers a great deal about wetlands, and joined together the community for a common goal. As educators, the 6th grade team made strides in interdisciplinary education.

The 6th Grade teaching Team at Bohemia Manor Middle School were:

Beth Kirk - Science
Carla Webb - English
Sandy Grimes - Math
Colette McCollum - Reading
Ted Gorzkowski - Social Studies

Environmental Enhancement

A school wetland is an aquatic laboratory that provides students with hands-on instructional opportunities in all school subjects. Wetlands add interest to the schoolgrounds while providing a source of endless discovery for students.

In addition to being an excellent educational resource, wetlands are a critical habitat for plants and animals. Non-tidal wetlands provide a buffer to streams as they filter, trap and biologically or chemically break down pollutants that run off developed lands and agricultural fields. Wetlands act like a sponge, helping to minimize flooding. Certain wetlands are important for groundwater recharge. Tidal wetlands are especially important as a nursery ground for many fish and shellfish.

Despite all the benefits, wetlands are still being destroyed nationwide at an alarming rate. Over the last 200 years, half of the wetlands in the United States have been eliminated (approximately 100 million acres of wetlands). Citizens, government agencies, and private organizations now realize the importance of wetlands. Since the 1980's a major initiative has been undertaken to restore some of the lost wetland acreage. By preserving and constructing wetlands on school sites, we can help the school community better understand wetlands and be an integral part of this national effort.

There are many different types of wetlands and they are classified by the dominant vegetation type and/or hydrology. An emergent marsh is the most popular type of wetland built on school sites. An emergent marsh is a pond that is shallow enough for plants to emerge from the water surface. Typically, marshes are less then 3' deep. Marshes are dominated by herbaceous plants, such as cattails, with shrubs and small trees on the edges of the flooded portion. In contrast to a marsh, a pond is deeper, and therefore, is primarily open water without plants. For safety reasons alone, a wetland is far superior to a pond in a school setting. Other types of wetlands include forested wetlands, scrub shrub wetlands, wet meadows, bogs, and fens. Depending on site conditions, there may be an opportunity to construct several wetland types on school grounds. Further discussion in this chapter focuses on designing and constructing an emergent marsh wetland.

Planning, Design, and Construction

New Construction and Renovation Projects

An ideal time to incorporate a wetland feature is during the planning of a new building or renovation project. In many cases the requirements for stormwater management can be met by designing a stormwater wetland as opposed to a dry or wet pond. Small pocket wetlands or rain gardens (see page 22) incorporated throughout the site will provide credit to stormwater calculations and can help significantly reduce the size requirements and cost of stormwater management. When engineering the site hydrology, consider using some or all of the water from roofs, parking lots, and fields to create one or many small wetlands. For example, many schools are built with a bus loop island of grass with curb and gutter. To make better use of the bus loop island, design it as a slight depression instead of higher ground. Channel runoff from the driveway and/ or the roof to the island and create a broad shallow marsh. Do not be concerned if the wetland does not hold water year round. Temporary or vernal pools provide vital amphibian breeding habitat and can be planted with an interesting diversity of plants.

Existing Schools

Many existing school sites are conducive to creating or even restoring wetlands. In order to determine if it is feasible to construct a wetland, begin by examining rainwater runoff. Each site is different and has different opportunities and limitations.

Selecting the proper site is the key to a successful wetland project. The four basic considerations are listed below. In addition, be careful not to alter an existing natural area to construct a wetland. Streams should not be diverted or dammed nor should a woodland be cleared to construct a wetland. Naturally occurring wetlands should never be altered while degraded wetlands can be restored.

Hydrology - There needs to be sufficient water feeding the wetland site. It is best to rely on surface runoff to supply the wetland versus groundwater which is usually not reliable due to fluctuations between seasons and from year to year. The volume of runoff will dictate the size of the wetland. See information below on determining runoff volume.

The following bullets address different school site features related to water sources for creating wetlands and offer ideas on how each feature can be used or manipulated for a wetland project.

- Rain water from rooftops and parking lots: These are two reliable sources of water. With rainfall, water runs off and eventually makes its way to a nearby stream. The premise is to intercept some or all of the water by building a shallow depression, a wetland, to hold the water. Channeling water from roofs or from paved surfaces with a curb cut are simple ways to divert rainwater.

- Ditches or swales: Options include plugging or partially plugging a ditch with soil in order to back up water and create a shallow flooded area. This can be done in conjunction with shallow excavation. The sides of a ditch or swale can be pulled back to create a shallow pool. A third option includes diverting water from a ditch with a pipe or open channel to the desired spot and excavating a shallow depression.

- A spring or seep: A spring in an existing woodland or wetland should not be disturbed because these areas often harbor unique or rare plants and animals. If a spring exists that is already disturbed (the side of a mowed hill or field) then capturing the water to build a wetland should not be a problem.

- Wet and muddy areas: For one reason or another certain areas on school grounds remain wet and muddy. If these areas are not jurisdictional wetlands and are not an existing natural area, a shallow excavation can create a vernal (temporary) wetland or, possibly, a perennial (permanent) wetland.

- Storm drains or grates: Grates in fields can be raised or a low earth berm constructed around drains to back up water. Be aware that sand or gravel may have been placed around the concrete riser that supports the grate. If this is the case, several inches of clay soil should be packed on top of the sand and gravel to prevent seepage around the riser. The berm should be constructed of heavy soil to minimize seepage.

- Pipes carrying stormwater: In certain cases, underground pipes carrying stormwater can be tapped diverting the water as a source for a wetland.

- Stormwater management basins: Excavate shallow depressions in dry stormwater basins to intercept and hold water to create small wetland pools. This should not alter the storage capacity of the structure. Excavated soil may need to be hauled off site. In certain cases, wet ponds can be planted with a marsh fringe and an upland buffer. Trees and shrubs should not be planted on the dam side of the structure. Their root system can damage the dam and allow water to penetrate. Work with design engineers for modifications of stormwater basins.

Slope of Ground - The more level the area the less earth movement required. If the area has a gentle slope, construct a series of shallow, narrow pools stepping down the slope. Steeper slopes are more difficult to work with.

Soil - The higher the silt/clay content of the soil the better. Soils with a silt/clay content over 21% drain slowly and are ideal for ponding water, thereby creating a wetland. A representative from the county Soil Conservation Service can determine if the soil is suitable for constructing a wetland. If the site has well drained soils, a layer of clay can be used as a liner to hold water. **Note:** The entire soil profile does not need to have poorly drained soils to construct a wetland. For example, if at a depth of two feet there is a 3" layer of silty clay then this should be sufficient to slow seepage and create a wetland. Be sure not to dig through this layer during excavation.

Vegetation - Students and school staff should be responsible for designing the wetland planting and installing the plants. Student planting plans can be reviewed and edited by a wetland specialist.

Wetland Design

While a wetland can vary from simple to complex, wetland specialists should be consulted for design and construction. Students can contribute concept designs. Certain secondary school classes may be able to complete a design and construct the project with guidance. While the concept of a wetland is simple, success is achieved by giving attention to details of design, construction, and maintenance.

Size - Building the largest wetland possible, given the limitations of the site, is a reasonable goal. Too often schools build a small wetland in areas where a larger project was possible. A larger wetland will allow a more diverse plant and animal community to become established and provide students more opportunities for investigation and discovery. Also, the impact to plants and animals from student use will be less if it is spread over a larger area. Creating several smaller wetland pockets with upland in between is a good option to creating a larger wetland.

Calculating runoff volume is not necessary on small wetlands. If you are unsure about the amount of water or the wetland is large, it may be necessary to calculate runoff volume. Refer to the USDA manual titled *Ponds-Planning, Design, Construction* (local Soil Conservation offices should have a copy). The ideal site has an ample supply of water so that the wetland remains at least saturated throughout the year. However, vernal or seasonal wetlands are an excellent option for drier sites. These wetlands remain wet through the winter and spring and dry out during the summer. Many wetland plants are adapted to this fluctuating water regime. Several species of animals, including many amphibians, are native to vernal pools. The lack of fish predators that eat tadpoles are the main reason many amphibian species seek vernal pools.

Shape - An irregular shape is best as it creates a more natural look. An irregular shape will make more nooks and crannies which provide a better habitat and make the wetland more interesting for exploration.

Depth and Micro-Topography - An optimal design includes broad shallow areas 0-6´´ deep interspersed with pockets varying from 12-24´´ deep. Slopes between shallow and deeper pools should be gradual for safety. This design allows emergent wetland vegetation to colonize most of the site with the deeper pockets remaining open. Deeper pools serve as a refuge for amphibians during droughts and also provide habitat for fish. Based on feedback from principals and teachers who have completed wetlands, an open water component is desirable especially from an aesthetic standpoint. If deeper pools cannot be added due to soil limitations or safety reasons, an open water feature can be accomplished by placing large flat rocks along the bottom in a few locations to deter plant growth.

Micro-topography refers to a rough uneven wetland bottom with subtle humocks (islands) and pools. This will allow for the greatest diversity of plant and animal growth.

Slopes - For easy access and safety, the upland area leading down to the wetland and the bottom contour of the wetland should be gradually sloped. A slope of about 5:1 or less is desirable.

Liners - If the soil in the proposed wetland area is well drained, fine textured (>20% clay) soil can be used to line the site and create poorly drained soils. Clay is a much better option then using a rubber liner. Unlike rubber, clay will not puncture or degrade. The use of clay is usually less expensive and it creates a more natural wetland.

Stabilizing Slopes - Slopes and disturbed areas need to be stabilized immediately. Typically, a mix of k-31 fescue and other non-native grasses are used to stabilize soil. While these mixes provide soil stabilization, they provide little habitat and k-31 fescue is an invasive plant. The Natural Resource Conservation Service has developed approved alternative mixes that are native and provide better habitat while stabilizing soil. These include:

- Dams and spillways: 25 lbs/acre each of creeping red fescue, hard fescue, and sheep fescue. Add 5 lbs/acre common white clover.
- Cut slopes or flat ground adjacent to wetland: 20-40 lbs/acre of oats or barley for quick soil stabilization. Add warm season grass/wildflower mix at 10 lbs/acre. A typical mix includes:

Grasses
Little bluestem *Schizachyrium scoparium*
Indiangrass *Sorgastrum nutans*
Switchgrass *Panicum vergatum*

Wildflower (add several of the following; many others are available)
Black-eyed susan *Rudbeckia hirta*
Beebalm *Monarda didyma*
Butterfly milkweed *Asclepias tuberosa*
Common milkweed *Asclepias syriaca*
Goldenrod *Solidago sp.*
Heath aster *Aster pilosus*
Lance leaved coreopsis *Coreopsis lanceolata*
New York aster *Aster novae-belgii*
New England aster *Aster novi-angliae*
Purple coneflower *Echinacea purpurea*
Wild bergamot *Monarda fistulosa*
Wild columbine *Aquilegia canadensis*
Wild blue indigo *Baptisia australis*

Legumes
American vetch *Vicia americana*
Bush clover *Lespedeza capitata*

Other Features - Partially submerged logs provide hiding and a basking spot for turtles and frogs. A wooden walkway or dock can be constructed on the edge or through the wetland. An enclosed wildlife observation blind can be built on the edge of the wetland.

Wetland Construction

Conserving Topsoil - Remove the topsoil and set this aside. Complete the excavation, install the liner material, if necessary, then spread the topsoil layer across the bottom of the wetland. Plants will grow much better in topsoil. Topsoil has important organic matter that provides the fuel for plants and the small organisms at the base of the food chain. Organic matter (e.g., mulch, straw) may be added to the wetland bottom and backslopes. Prior to excavation, it may be necessary to roto-till or disc the sod if it is a dense mat.

Topography - Most equipment operators take pride in building smooth even pond bottoms. Be sure to convey to the contractor that the bottom is to be rough and uneven.

Erosion Control - Erosion control fabric should be used in spillways or swales where moving water could erode soils. Mats of sod can be scraped off the excavation site, then used in place of erosion control fabric. Wetland vegetation should be planted for long term erosion control.

Liners - If a clay liner is used, the clay should be kept moist for easy spreading and not allowed to dry out after construction. Use three to five inches of clay. Six to eight inches of topsoil or loamy soil should be spread on top of the clay. This will provide a good substrate for the roots of the wetland plants. Adjust the depth of excavation to allow for the clay liner and soil on top of the liner. If a rubber liner is used, eight to ten inches of soil should be placed on top of the liner. Wetland plants can then be planted directly into the soil. Soil is an integral part of a wetland system.

Wetland Buffer - Two general types of buffers can be planted around a wetland. The first is a buffer of trees and shrubs. The second is a grassland/wildflower meadow buffer. If a grassland buffer is planted, a few shrubs should be planted on the wetland edge, as these will provide important habitat for birds and amphibians. The buffer should be a minimum width of 25 feet and wider if space allows.

Planting Plan - It is suggested that students complete this exercise, then have their plant list reviewed by a natural resource specialist. Order nursery catalogs from wholesale wetland nurseries for students to use. Select plants native to your site and select wild varieties over cultivars.

Table 5 lists plants by moisture zones native to Maryland and widely available through nurseries. This is not a comprehensive list.

ZONE 1 Upland

shrubs
Sweet Pepperbush (Clethra alnifolia)
Spicebush (Lindera benzoin)
Highbush Blueberry (Vaccinium Corymbosum)
Arrowwood (Viburnum dentatum)

trees
Shadbush (Amelanchier canadensis)
River Birch (Betula nigra)
Hackberry (Celtis occidentalis)
Persimmon (Diospyros virginiana)
Tulip Poplar (Liriodendron tulipifera)
Willow Oak (Quercus phellos)

ZONE 2 Wetland Edge

shrubs
Smooth Alder (Alnus serrulata)
Buttonbush (Cephalanthus occidnetalis)
Silky Dogwood (Cornus amomum)
Red-osier Dogwood (Cornus stolonifera)
Winterberry (Ilex verticillata)
Elderberry (Sambucus canadensis)

herbaceous plants
Swamp Milkweed (Asclepias incarnata)
New England Aster (Aster novae-angliae)
Joe Pye Weed (Eupatorium dubium)
Soft Rush (Juncus effusus)
Cardinal Flower (Lobelia cardinalis)
Switchgrass (Panicum virgatum)
Woolgrass (Scirpus pungens)
New York Ironweed (Vernonia noveboracensis)

ZONE 3 Shallow Wetland 0-6"
Sweet Flag (Acorus calamus)
Tussock Sedge (Carex stricta)
Rose Mallow (Hibiscus moscheutos)
Blue Flag (Iris versicolor)
Three Square (Scirpus pungens)
Eastern Bur-reed (Sparganium americanum)

ZONE 4 Deep Wetland 6-12"
Pickerelweed (Ponederia cordata)
Duck Potato (Sagittaria latifolia)
Lizards Tail (Saurrus cernuus)
Soft Stem Bulrush (Scirpus tabernaemontani)

Sample Native Plants for Moisture Zones within a Wetland

Table 5

Long Term Maintenance

Monitoring and observing changes over time is the key to making management decisions. It is very helpful to work with a wetland specialist or botanist to provide guidance. The following are some general maintenance guidelines.

- Removing invasive exotic species: Phragmites and purple loosestrife are the two non-native species of concern, although there are others. Cattails, while native, can be very aggressive and should be monitored carefully. Cattails are well adapted to grow in disturbed areas such as stormwater management ponds. In these areas it may be an uphill battle to control cattails as they will return each year. It may be best to let the marsh develop as a cattail marsh.
- Colonization by other plants: Other plants will colonize the site. This is a natural process that will add to the diversity of your habitat. Some may compete with your plants. If the colonizing plants are not invasive, it is best to leave them alone.
- Adding more plants: Some wetland plants spread rapidly; therefore, it may not be necessary to add plants. If you need to add plants, wait until late in the spring after dormant plants have come up to avoid crushing the dormant plants.
- Watering: Upland plants need to be watered for at least the first summer after planting.
- Coordination with maintenance staff: It is essential to let the maintenance staff know where to mow and where not to mow. Un-mowed areas should be marked with stakes or a diagram. One of the single biggest frustrations associated with school habitat projects is new plantings being damaged or killed by mowing.
- Water fluctuation: Many plants adapt to natural fluctuations in water levels. However, if the water either floods too deep or too often, or dries out too much then certain plants may not survive. Therefore, it is important to keep track of which species survive. More often then not, too much water is the cause of plants not surviving. There are other reasons for plants dying such as poor planting technique, poor nursery stock, or disease but water levels play a major role in plant survival.
- Erosion: Watch closely for rills that may develop from moving water especially if a low berm or dam was constructed and overflow water moves through an established swale. Mats of sod can be used to stop erosion in swales. Willow stakes can be used to combat erosion. A low check dam(s) can be constructed to control flow, reduce erosion, and dissipate energy in swales. As a last resort, the swale can be lined with rock.
- Siltation: Through siltation, the depth of the wetland will reduce over time. This is a natural process. Reducing erosion in the drainage area will slow down this process. A decision should be made if and when to remove silt or to let the natural process continue.
- Adding animal species: One of the most common questions about wetland projects is: Should I add fish, frogs, or turtles? There is no need to add your own frogs or turtles (unless your site is in an enclosed area or highly urbanized) as they will find their way to the wetland if it meets their habitat needs. Because many amphibian species only use wetlands to lay eggs, the adults may not be seen. Other species are more water dependent and will inhabit the wetland longer. Fish will unlikely colonize your site unless it is connected to a stream or river system. Since fish eat tadpoles, many species of amphibians will only lay their eggs in wetlands that do not contain fish. The majority of fish species require 4' of water to survive winter freeze and summer heat. Therefore, a decision to include fish will be based on: a) a wetland having a deep area where fish can survive and, b) an interest in providing habitat for fish. Since there is a worldwide decline in many amphibian species, it is recommended not to add fish unless they meet a specific educational goal.

Cost

The cost of constructing a wetland can vary widely depending on size, amount to be excavated, amount of work, and materials donated. The following list gives some general thoughts about costs:

- Design: On an existing site, the county Soil Conservation Districts are very helpful at completing wetland designs at no cost. The U.S. Fish and Wildlife Service is also available to consult on design. Engineering firms or universities may be able to complete designs at no cost as a public service. Some county public works engineers will provide design assistance. On a new school site, the cost of designing a stormwater wetland should not be significantly more than the typical stormwater management pond.

- Construction: Earth moving can range anywhere from $1.80 to $4.00 or more a cubic yard. Contractors have been very generous in providing excavation at reduced rates or at no cost when approached to excavate a wetland for an existing school site. For new school design, the excavation costs of a good wetland design will be slightly more than a typical stormwater management pond.

- Construction materials: Seed, straw, and erosion control fence shouldn't cost more then a few hundred dollars.

- Plants: For a 1/4 acre wetland site, plants can be purchased for $500 - $1,000. Grants are easily obtained to cover all the costs. Natural colonization of wetland plants will fill in any gaps. In subsequent years, focus on planting a shrub or meadow buffer around the wetland.

The Chesapeake Bay Trust (410-974-2941) and Department of Natural Resources Aquatic Education Program (410-260-8716) can provide funding for plants, educational materials, and possibly construction costs. The U.S. Fish and Wildlife Service Partners for Fish and Wildlife Program (410-573-4500) can provide technical assistance and a limited amount of funding.

Student Participation

Student participation should be a primary focus of the project as students will take ownership of the wetland if they participate in the planning process. This is especially true for establishing a wetland on an existing site. Some of the ways students can get involved include:

- completing an initial site study,
- sketching a concept design for the size and shape of the wetland,
- selecting plant species,
- developing a planting design,
- installing plants,
- watering plants,
- writing grants,
- soliciting donations from parents and businesses,
- writing a press release, and
- presenting the project to the community and board of education.

Since each project is different, teachers can work with a natural resource specialist to decide how students can be involved. The U.S. Fish and Wildlife Service has developed a guide to help teachers lead their students through the process of planning a wetland. For a copy of this publication call 410-573-4500.

Safety

Slopes adjacent to and within the wetland should be very gentle. Water depths should be kept under 2 feet. Following these basic guidelines will insure a safe wetland site. Fencing should only be used if required. Fencing isolates the wetland from certain wildlife species. Fencing also sends a confusing message to students about natural areas being dangerous or off limits.

Other Concerns

Mosquitoes - Many mosquito species breed in temporary pools of water that lack larval predators. Established permanent wetlands with aquatic plants have a variety of aquatic insect predators including dragonfly larvae, diving beetles, and water striders that eat mosquito larvae. A small established wetland will harbor a few more mosquitoes then upland habitat but it should not significantly add to the local mosquito population. If mosquitoes become a major problem, mosquito fish can be added to the wetland. They are available from the Maryland Department of Agriculture.

Snakes - Snakes are part of the natural ecosystem that play a key role in the food web both as predators and prey. **There are no poisonous water snakes in Maryland.** The northern extent of the poisonous water moccasin is in the Great Dismal Swamp in Southern Virginia. Young northern water snakes have a banded pattern and have been confused with water moccasins. Northern water snakes can be quite curious and sometimes aggressive. However, they are not harmful and will not bite unless provoked.

Plants of Concern - No plant parts should be eaten unless known to be edible. Stinging nettle is a plant that should be removed if found on site. Rice cutgrass (a native wetland plant) should not be planted as the leaves have sharp edges and can cut skin.

Regulatory Requirements

Wetlands are regulated by Section 404 of the Clean Water Act. A permit is required when a wetland is disturbed or altered. If a site has wetland characteristics (persistent saturated or ponded soil, gray or mottled soil color, and or hydrophytic vegetation such as rushes, sedges, or cattails) invite a representative from the Maryland State Department of the Environment to the site to make a decision on whether a permit is needed. If the site is an upland no permit is necessary. A sediment and erosion control plan is needed if more then 5,000 sq. ft. of soil is disturbed.

GARDENS

Arbor
Judith A. Resnick Elementary School
Montgomery County Public Schools

Case Study: Gardens

The Judith A. Resnick Elementary School in Montgomery County was an attractive new brick school wrapped around a 80′ x 120′ courtyard crisscrossed with concrete paths and dotted with unremarkable vegetation. Corridor and classroom windows looked onto the courtyard; the media center and corridor doors open into it. But there was nothing to see and no reason to enter it. In 1995, with the support of the principal and staff, the PTA undertook as its goal a three year transformation of the courtyard into an outdoor science center/garden. The purpose of this effort was to provide hands-on opportunities to enrich and supplement classroom instruction. With the help of a wildlife specialist, they developed a wishlist of features which included ponds (a control and an experimental site), raised-bed gardens (approximately 40 of their 630 students are orthopedically disabled), an extensive arbor to provide shade and to act as a climbing structure for vines, a Colonial Maryland herb garden (including medicinal, culinary, and dye plants), a butterfly garden, a wildflower garden, a weather station, a composting site, seed planting areas, and wildlife habitat.

The plan was implemented in stages. First, the ponds were dug. They were placed next to the corridor windows where passing children could see the new pond lilies unfold into bloom and monitor the darting native fish. Next, the existing alkaline soil was heavily amended to allow the planting of native (acid-loving) plants. This took a year of planning, fundraising, and working. A biologist parent took the lead in coordinating the project. Her family lived across the street and spent endless hours developing and tending the courtyard. (A plan for rotating the care during the summer, using a different family a week worked better on paper than in reality).

In the next phase a crane lifted timbers over the school building to create the arbors. Native vines were planted at the bases of the uprights. A shed for garden tools was added as were covered plastic vermin-proof composting bins (to which children add their lunch scraps). Raised beds, at wheelchair height, were filled with composted leaf soil, and planted with quick-crop vegetables. Bird feeders and a sundial in which children stand to make the shadow add to the educational opportunities.

Raised, ADA Accessible Garden
Judith A. Resnick Elementary School
Montgomery County Public Schools

Exploring the Garden
Judith A. Resnick Elementary School
Montgomery County Public Schools

Children have been involved in all phases of maintenance and in monitoring the growth and changes in the courtyard. Monthly newsletters keep the staff and community abreast of any interesting developments. An annual "Courtyard Guide" has been published and distributed to all staff members, complete with a reduced copy of the original plan and with information on all of the resident plants and animals. At first, only a few teachers used the courtyard, but usage has increased substantially as the curricular connections have become apparent.

Contribution to Educational Programs

Gardens discussed in this section are of the traditional flower-and-vegetable type, familiar to many adults, and found around many homes in borders and containers. Adult familiarity is a great advantage of these gardens -- many teachers and aides feel they can guide children in the process of selecting, planting, and tending to plants so readily available in garden stores. The job of facility planners, architects, landscape architects, and curriculum planners is to facilitate school gardening through thoughtful design.

Gardening is a worthwhile pursuit for children and adults of all ages and abilities. As a vehicle for interdisciplinary environmental education, gardens are excellent. Many science, math, social studies, and language arts goals for Maryland students can be approached through gardening. Understanding of life cycles and the interdependence of living organisms and the non-living environment are examples. Because gardening is such a flexible, adaptable activity there is no set of specifications, but rather a set of guidelines to be adapted for different aged children and different school sites.

Planning, Design, and Construction

Locating Gardens

Gardens need light, water, appropriate soil, drainage, and protection (e.g., from balls, foot traffic, and roof drainage). If possible, school gardens should be located close to classrooms so they can easily be tended and monitored by children and teachers. Gardens must be accessible to individuals with disabilities. Secure storage space for tools and equipment should be nearby, as well as provision for properly vented and protected composting. Water must be easily accessed.

IDEAS FOR GARDENS

Native American Three Sisters: corn, beans, squash
Salsa: hot peppers, tomatoes, cilantro, onions
Quick Salad: leaf lettuce, radishes
Butterfly: native plants to attract native butterflies
One Color: choose a color and see how many shades exist
Wildflower: include black-eyed Susan, Maryland's state flower
Colonial Maryland: medicinal, culinary, and dye plants
Persian Rug: children make a pattern and plant it with flowers
Multicultural: plants or seeds from children's countries of origin
Alphabet: marigold's for "M", etc.
Xeriscape: plants that once established survive with little or no watering

Table 6

Classrooms in many schools have doors that lead directly outdoors, providing access to gardens. Gardens should be located far enough away from structures to allow children to work on all sides of the garden. In new construction, each garden should have a water supply; retrofitting can extend an existing water supply to the outside of the building.

Courtyards are prime garden locations as they can provide security for the gardens and equipment shed, access to water, low traffic, and interesting views for adjacent rooms or corridors. Materials used in courtyards should be selected to control excessive heat from the sun. Retrofitting courtyards may be more difficult than adding to the perimeter of the building (e.g., delivering large lumber for a courtyard arbor or new soil and timbers for raised beds).

For an extensive garden area, one elementary school created 108 4x6 foot plots, located a storage shed/ greenhouse with multiple hose bibs in the center, and ringed it with a fence including a locked gate. There was a garden plot for every four children. Secondary schools, particularly ones with a related educational focus, may require a similarly large area for curriculum.

Providing water is necessary if extensive gardening is foreseen. It is vital that water is close to the gardens, otherwise the labor of tending the plants becomes too burdensome for all but the most dedicated teachers, students, and parents.

Flower and vegetable gardens require a minimum of 5-6 hours of sunlight. The garden area must be carefully selected to avoid long periods of shade from the school building or from trees.

Gardens should be a permanent part of the school design and should not be located where expansion is slated to occur. Good gardens should last for years with the soil constantly being improved and perennial growth encouraged and monitored. Gardens typically require a great deal of work by teachers, parents, and custodians; providing permanent locations for gardens respects and sustains this work.

If children's gardens are to be considered a positive part of the landscaping of the school, just as children's art is considered desirable interior decor, similar aesthetic standards need be applied. If there is a preference for a formal landscape in highly visible areas, such as the main entrance, locate children's gardens less conspicuously.

Soil - In new construction, some of the site's topsoil should be reserved for school gardens, a step which is both practical and provides an authentic basis for growing native species. In adding gardens to existing buildings, fresh soil and amendments will usually be required, particularly if beds are near the buildings where soil is usually poor. Bulk top-soil is of uneven quality and therefore, should be purchased carefully. A composting program will contribute to soil quality in an ongoing garden program.

Inexpensive soil testing by the Cooperative Extension Service provides information on minerals, nutrients, and pH values. Lead testing is recommended for older school sites. If lead is present, replacing existing soil with fresh soil is the only alternative.

Types Of Beds - Garden beds range from ground level to wheelchair accessible level. Raising a bed 8-12" high delineates it from its surroundings so it is not disturbed by pedestrian traffic. The top should be suitable for sitting (wide and smooth, with rounded edges). Some beds for prekindergarten and elementary school children should be 22-28´´ high to meet the requirements of the Americans with Disabilities Act for accessibility. For secondary school children, a 20-30´´ bed height will provide accessibility. The advantages to raising beds are protecting their contents, especially in high activity areas, allowing drainage, and simplifying soil preparation. For ideas on accessible gardens, see The Enabling Garden (page D-2, References).

The size and shape of beds vary enormously depending on the site. Narrow rectangles allow children to work easily without getting into the garden. If squares and circles are used, paths are needed. One school created a large square garden available to young children by using large tiles to create a checkerboard of soil and working spaces where children could kneel and sit. A series of planters can be arranged to give children the interest of pathways.

Obviously, cost varies with the size and materials used. A recently constructed 4´x12´x3´ bed using 6´´x6´´ timbers, lined with filter fabric (to prevent soil from seeping between the timbers) cost about $1000 for materials and labor. See Play for All Guidelines (page D-2, References) for further ideas on creative garden design for schools.

Plantings - Plantings vary according to the goals set for the garden. A class of 4-year-olds may want all red flowers, chosen from seed catalogues; a class of second graders may want to select plants in hopes of attracting butterflies as part of their life cycle studies; a kindergarten class studying nutrition wants a vegetable garden; a fourth-grade teacher may want to plant colonial species to enrich a social studies focus on Maryland history; the art teacher may want a sunflower bed to link with paintings by Monet, O'Keefe, and VanGogh; and social studies and science teachers may want only native species to teach a sense of place and environmental sensitivity. Well designed and constructed gardens accommodate all these curricula.

Long Term Maintenance

The most common downfall of school gardens is lack of maintenance when school recesses for the summer. There are two ways to handle this potential problem. The first approach is to have someone, or ones, tending the garden: a community group, e.g., a Boy Scout Troop, the same dedicated parents and teachers who started the garden, a summer school teacher, or a school neighbor. Access to water and good mulching go a long way to making the job easier for these gardening stalwarts. If considerable funds and time have been invested in perennials and shrubs, such on-going maintenance is necessary.

The second approach is to use the garden only for plants that mature by May having been planted earlier in the fall or spring (peas, lettuces, radishes, pansies, and bulbs such as tulips) and for plants that can be planted in late August or September and mature by the end of October (spinach, beets, chard and lettuce from seed, broccoli from seedlings). When fall vegetables are harvested, spring bulbs and pansies can be planted. When peas are planted, potatoes can be also planted -- being fairly sturdy they might make it through the summer untended and can be a total delight to dig up in September. A big garden might have room for Heritage raspberries that do not need significant tending, bear fruit in the fall, and are trimmed down before the next growth in the spring. If there is space for sprawling, planting and mulching, pumpkin seeds might provide a fall crop, given any luck with summer rain for watering.

If the decision is for no summer growing, the garden should be cleaned up and mulched as school closes in June to avoid an unsightly weed patch the seeds of which will haunt all future efforts. A fall clean-up is necessary and fall is also a good time to add in the compost that has been accumulating.

Student Participation

Working within the considerations suggested above, secondary students can contribute substantially to making gardens; elementary students are more appropriately provided good beds in which to experiment with varieties of plants and arrangements. With a good bed, children can devise many interesting conditions of soil, light, water, and temperature to study plant growth, as well as help decide the type of garden.

STREAMS

Students Sifting for Microinvertebrates
Towson High School
Baltimore County Public Schools

Students Studying Health of Streams
Towson High School
Baltimore County Public Schools

Case Study: Streams

At Towson High School in northern Baltimore County, the 11th and 12th graders are learning about and restoring a schoolyard stream environment. As the final project for the Chesapeake Bay Course (one semester/elective), students were assigned a small, three meter wide, riparian area to restore. Using the Save Our Streams publication, *A Citizen's Streambank Restoration Handbook* (page D-2, References), students assessed the stream, developed a restoration plan, then carried out the restoration. The 1997/98 school year was the first year of this project.

Funding for this stream restoration was provided by the Herring Run Watershed Association and the Baltimore County Forestry Board for trees and the Chesapeake Bay Trust for chemical kits.

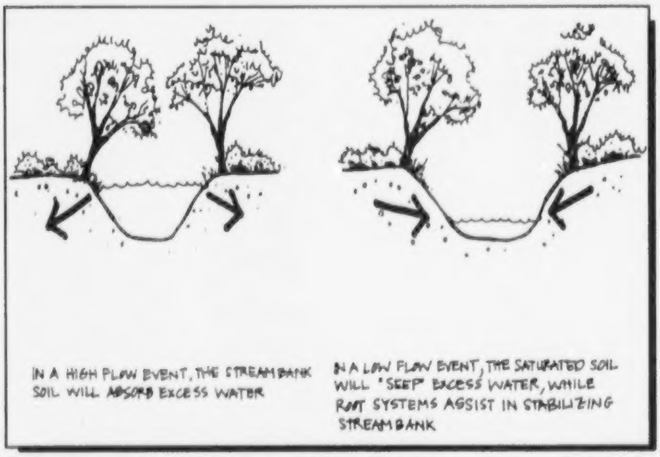
The teacher of the Chesapeake Bay course at Towson High School said, "One of the goals of this class is to teach students ways in which they can actually do something to help the health of the Bay. We go by the motto of 'Nobody made a greater mistake than he/she who did nothing because they could only do a little.' Along with the community newsletter distribution and the stream restoration, the students actually make a contribution to saving the Bay."

Environmental Enhancement

Stream ecosystems that flow on a school site provide many opportunities for students, faculty, and administrators to learn about local water quality and wildlife habitats. These unique ecosystems are the school's direct link to the Chesapeake Bay and Maryland's efforts to restore this endangered estuary. As stewards of a school site stream environment, students, teachers, maintenance, and administrative staff have an opportunity to learn about and understand how streams work, hopefully becoming active in projects that will protect and restore these fragile ecosystems so vital to the Chesapeake Bay.

Ways in Which Healthy Stream Ecosystems on School Sites Help the Environment

- Provide protected areas along stream banks, for trees and wetland plants. These areas known as, *riparian buffer zones* should be not less than 25 feet in width.
- Wildlife use forested buffer strips to travel to and from feeding areas, and for seasonal migrations. These corridors are located along streams because stream buffers provide shelter and protection from predators and human disturbances.


IN A HIGH FLOW EVENT, THE STREAMBANK SOIL WILL ABSORB EXCESS WATER
IN A LOW FLOW EVENT, THE SATURATED SOIL WILL "SEEP" EXCESS WATER, WHILE ROOT SYSTEMS ASSIST IN STABILIZING STREAMBANK

Streambank Vegetation Serves Many Purposes Figure 8
(Izaak Walton League of America)

- Riparian buffer areas provide opportunities for students to design and implement habitat enhancement projects such as bird, squirrel, and bat boxes, as well as tree and shrub plantings to attract wildlife.

- Stream buffers can filter stormwater runoff from athletic fields, tennis courts and buildings.

- By planting trees within the riparian buffer, students will be actively participating in a new statewide mandate to plant 2,010 miles of streamside buffer strips by the year 2010. The Maryland Department of Natural Resources Forest Service can provide advice and trees for many planting projects on public land. This effort will help Maryland meet a very important goal to improve local water quality and ultimately restore the vitality of the Chesapeake Bay.

Contribution to Educational Programs

A student's educational program from elementary age through high school can be enhanced by learning outdoors. The opportunities to apply lessons to local environments and environmental issues, specifically using elements of a local stream system are limited only by the imagination of the teachers.

Having a stream ecosystem and its associated riparian buffer on or near campus is a valuable opportunity for teachers and students to get involved with global issues and efforts to improve their environment. Stream ecosystems are an excellent resource to:

- Begin investigations in the fields of physics, engineering, geology, and biology. For example, stream velocity and channel sinuosity studies can help students learn real life applications for mathematical studies.

- Conduct research on fish species and aquatic habitats.

- Develop and implement habitat enhancement projects that could provide for student service learning credits and valuable lessons regarding environmental stewardship.

- Provide inspiration for students writing and art expressions about their local community or a natural ecosystem.

Planning, Design, and Construction

As the appointed stewards of public land, school facility planners, and administrators are charged with an enormous responsibility to consider all phases of a construction operation and how a project will affect local waterways. Most of these considerations are directed by state and federal laws, but many design and construction decisions and activities can be geared toward how to better protect a school site stream, or in the case of a stormwater retrofit, improve the ecosystem for future generations of students.

Infiltration is vitally important for stream protection. The dynamic, yet stable geometry of stream channels evolved in mostly forested watersheds where 85% of runoff entered streams slowly through groundwater seepage and 15% from overland flow. In watersheds where a significant amount of forest is cleared, the percentages are reversed. Overland flow translates into large volumes and increased velocities causing streambank erosion that smothers aquatic life and fills navigation channels with silt.

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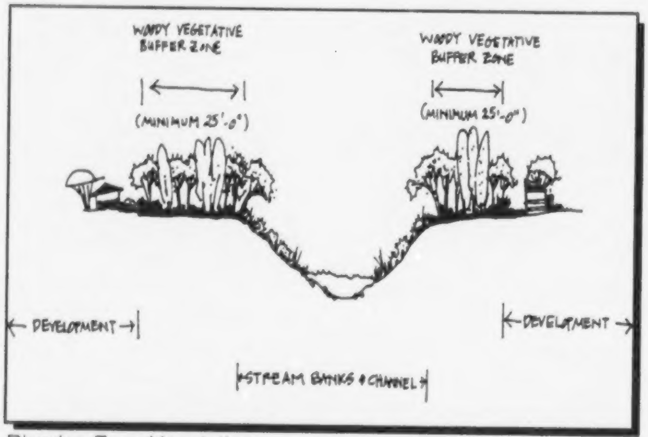

WOODY VEGETATIVE BUFFER ZONE
(MINIMUM 25'-0")
WOODY VEGETATIVE BUFFER ZONE
(MINIMUM 25'-0")
DEVELOPMENT
DEVELOPMENT
STREAM BANKS & CHANNEL

Riparian Zone Vegetation (Izaak Walton League of America) Figure 9

Through planning of construction projects, consideration should be given to stream protection beyond mandated guidelines. Every opportunity should be made to promote infiltration of rainwater. This generally means reducing the quantity of stormwater from a site that is directed to a basin. A variety of techniques used at a smaller scale throughout a site can greatly aid infiltration while significantly reduce or eliminate the need for stormwater management basins. Some of the techniques include bioretention (rain gardens), open grass swales, sand filters, wetlands and porous pavement. Many resources are available on this topic. A local group, the Center for Watershed Protection, has two excellent design manuals: Design of Stormwater Filtering Systems and Site Planning for Urban Stream Protection (page D-2, References).

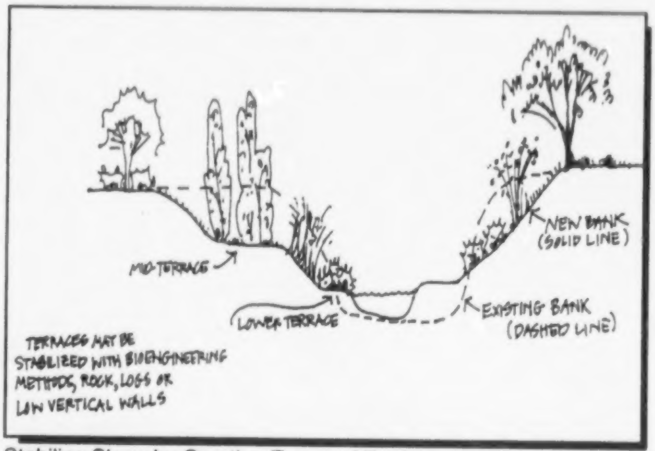
There are five different physiographic regions in the state of Maryland. They are: *coastal plain, piedmont, blue ridge, ridge and valley, and the Appalachian plateau.* These areas are defined by distinctive geographical features. Each of these regions have specific types of watershed characteristics and runoff patterns with regard to stream ecosystems. It is important to know in which type of physiographic region your stream is located. This information will lead to a better understanding of drainage patterns on and around the school site and will help school staff understand more about the aquatic species and habitats of the stream.

When planning for school facilities, it is imperative that certain school operations be located away from stream areas and that adequate stormwater considerations be addressed so that these operations will not affect the water quality and buffer stability of the riparian areas.

Stormwater Runoff Areas and Pollution Sources

- school maintenance areas
- cafeteria and kitchen
- athletic fields
- green houses
- basketball and tennis courts
- parking facilities
- career education facilities for programs such as automotive services, carpentry, small engines, and welding areas

Any construction project, whether it is new construction or renovation of an existing facility, which disturbs 5,000 square feet of soil will require an approved sediment and erosion control plan. Check with the appropriate county agency for details. Construction projects should be designed to avoid disruption of stream buffers and 100-year flood plains. If


MID-TERRACE
LOWER TERRACE
NEW BANK (SOLID LINE)
EXISTING BANK (DASHED LINE)
TERRACES MAY BE STABILIZED WITH BIOENGINEERING METHODS, ROCK, LOGS OR LOW VERTICAL WALLS

Stabilize Slope by Creating Terraced Banks (Izaak Walton League of America) Figure 10 construction in the floodplain or 100-year floodplain is unavoidable, as in a road or trail which crosses a stream, permits will be required from Federal and/or State regulatory agencies. Contact the Maryland Department of the Environment to determine specific requirements.

One relatively new and interesting stream rehabilitation effort emerging on the environmental restoration scene is the concept of "*daylighting*". This is an attempt to take long buried stream hydrologic systems and restore them to free flowing uncovered environments. Although costly, stream *"daylighting"* is a worthwhile project. Many streams that used to flow through neighborhoods were encased in concrete culvert type structures years ago to facilitate the building of roads, communities, schools, and even athletic fields. The idea was that by burying the stream, the developers could better control stormwater runoff and erosion. With recognition of the value of having an ecologically viable stream in a community, restoration efforts are increasing that remove culvert structures and restore a stream's natural channel and flow. For more information about stream "*daylighting*" call the Coalition To Restore Urban Waters coordinator at the Izaak Walton League of America (1-800-BUG-IWLA).

Long Term Maintenance

Riparian buffers should require little maintenance if they are not excessively disturbed. However, it may be necessary to do periodic planting if school activities result in damage to vegetation. If exotic invasive vegetation (e.g. Japanese honeysuckle, oriental bittersweet) is overwhelming native vegetation, a control program may be necessary.

Trails or roads which provide access to or cross streams should be checked on a regular basis to ensure that erosion is not occurring.

Stormwater management facilities must be maintained on a regular basis to ensure that they are functioning properly and are in compliance with applicable statutes, such as the Maryland Dam Safety Regulations. Areas downhill of all school facilities, including athletic fields, should be checked periodically to ensure that runoff is not causing erosion.

Student Participation

Student participation can take many forms as suggested by the following examples:

- Site rehabilitation concept and design--identification of problems and design considerations.
- Organize a group project to remove stream barriers to fish migrations (be sure to call a local stream ecologist before removing instream barriers such as tree limbs--they could be providing important aquatic habitat for insects and fish).
- A stream clean-up is an excellent way to improve not only water quality but the aesthetic quality of a stream environment and it encourages stream neighbors to do their part to keep out trash.
- Buffer planting--all phases from design to implementation.
- Stormwater retrofit--students working with engineers and landscape architects.
- Public education campaign--write an article for the school newsletter, contact the local paper or submit a letter to the editor, organize and host an education forum for the neighborhoods along the stream, produce a public service announcement for the local cable TV station.
- Grant writing--students can write a grant to help fund monitoring equipment and restoration materials.
- Learning about the County/Municipal permit processes.
- Fundraiser--have some fun--throw a party to raise awareness and money to support the project.

Safety

All activities outdoors involving student groups should follow precautions to ensure the safety of those working in or along waterways.

Stormwater-flooding - Throughout Maryland's Piedmont and coastal plain regions, flash flooding during and after severe rain showers can be a threat to human safety in and along stream corridors. In highly impervious urban areas this situation is more prevalent and should be identified to all teachers and student groups involved with stream studies. Most radio and TV weather reports will include flash flood alerts. Teachers and students should cancel all stream related activities if the local weather forecast includes a flash flood alert.

Access-Erosion - With all outdoor activities, footing on uneven ground can be hazardous. Stream banks are dynamic environments and care must be taken to identify safe access areas that do not require students to climb down steep or highly eroded banks. Access areas should be relocated over time if large numbers of students are using them. This will lessen the impact to the bank and ensure the safety of the students.

Remote Study Areas - Stream corridors are usually heavily wooded and located away from school buildings. Students need to stay with a group or a partner during all stream related activities. Care should be taken walking in streams because of algae covered rocks, soft sediment, or submerged objects. Students should wear only shoes that tie on or boots - sandals are not recommended. A cellular phone or hand held two-way radio should be carried by a teacher to contact the school in the event of an emergency.

Pollution - Because streams are located at the lowest point in watersheds, trash and woody debris are constantly being washed into them during storm events. In addition, the remoteness of these environments can attract illegal dumping of trash and yard waste. It is imperative that teachers scout a stream site before student trips. Such hazards could include hypodermic needles, broken glass or drums with unidentifiable substances.

Water pollution that is hard to identify such as an oil or chemical spill can be dangerous to human health. Before students enter a stream, the teacher or group should scan the water surface. If the water is cloudy or has an unusual color or odor do not allow the stream water to come in contact with the skin, mouth or eyes until it has been checked out by a local water management authority. It is imperative that a student or teacher report all suspicious water pollution. The Maryland Department of The Environment has a water pollution hotline; (410) 974-3551, and so do many local government agencies and public works departments.

Regulatory Requirements

Streams are regulated as wetlands under section 404 of the Clean Water Act. Additional regulations may vary by location, water use classification, and county. Check with the Maryland Department of the Environment and appropriate county agencies to determine which regulations apply.

References

Maryland Department of the Environment. 1994. Maryland Standards and Specifications for Soil Erosion and Sediment Control.

Maryland Department of the Environment. 1987. Design Procedures for Stormwater Management Extended Detention Structures.

Maryland Department of the Environment. Draft Maryland Stormwater Design Manual. Available on MDE website, http://www.mde.state.md.us

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USDA, Soil Conservation Service. 1982. Ponds--Planning, Design, Construction. SCS Agriculture Handbook No. 590.

Table 7

Chapter 4

Other Considerations

Paths

Structures

Habitat Components

Boardwalk
Yough Glades Elementary School
Garrett County Public Schools

PATHS

Boardwalk, Yough Glades Elementary School
Garrett County Public Schools

Paths to and through natural environments on school sites must be accessible to individuals with disabilities. The surface must be stable, firm, and slip resistant. Soft, loose, or irregular surfaces will hamper the movement of a wheelchair and create hazards for people using other mobility aids. Often the settings for these paths make concrete inconsistent with the look and experience desired for students and staff. These paths are sometimes lengthy which precludes the use of more costly materials such as concrete. For these reasons, other materials need to be explored that meet aesthetic, cost, and accessibility requirements. The project architect will have to study the slopes, soils, and other aspects of the location for the path, to determine the best specifications.

One type of path that has had success in national parks is one with a compacted aggregate base and a crusher run top surface including an additive material to stabilize the surface. The subgrade should be compacted to 95% density. If there is concern about vegetation growing through the path surface, a geofabric should be placed underneath the base course. All existing vegetation should be removed or killed prior to placing the fabric. The base course should be 2-4 inches of crushed aggregate compacted to 95% density. If possible, use a steel-wheeled vibratory type roller, otherwise use nothing less than a vibratory plate compactor. At least three passes of the compaction equipment should be used. The finish surface should be 2 inches of crusher run, 1/4″ aggregate and less, with an added stabilizing material. The finish surface should be steel wheel rolled. The path should be edged. One inexpensive edging is PVC designed for that purpose with 2″ x 2″ stakes 48″ on center.

The width of the path should be 36″ - 48″ but can be narrowed to 32″ - 36″ for short distances if the path must pass through restricting natural settings such as rock formations or large trees. Level 60″ x 60″ rest and passing areas should be provided every two hundred feet. Ideally, the path should not exceed a 5% slope (1:20). If the slope of the path does exceed 5%, that portion of the path is classified as a ramp and should have level landings every 30 feet. In all cases the maximum slope of a ramp is 1:12.

There are several types of stabilizers. Class "C" flyash is an inexpensive stabilizer provided there is a source of this material relatively close to the construction site. The quantity of quicklime in flyash varies from place to place. Class "C" flyash contains a sufficient quantity of quicklime to be of benefit when stabilizing surface material. The flyash helps to cement the aggregate particles together and this takes place when moisture is added. Usually about 5% flyash is used by dry weight of materials being stabilized. A good practice is to complete a test area to determine the exact amount of flyash to be added. Once moisture is added to the mixture of crusher run and flyash, the surface should be quickly leveled and compacted since the material may set-up in as little as fifteen minutes.

Another stabilizer choice is ground seed hulls, a patented, organic, nontoxic material manufactured from the seed hulls of the plantego, a plant native of Arizona. This product has been manufactured since the mid 1980's. The stabilizer is odorless and will not stain the materials it is mixed with. It has been successfully used in cold climates and works well with surface material that are 1/4″ or less in diameter. With a 2'' deep surface material about one pound of stabilizer is used for every 12 square foot area. Applying the stabilizer involves thorough and uniform mixing, watering, and compacting. The finish surface will soften when it contains moisture, during and after a rain, but will stabilize as it dries out. The stabilizer is easy to repair when the surface material is damaged by reforming the damaged area, rewetting, and compacting. If additional material is needed, the aggregate and stabilizer are mixed, placed in the location, graded, wetted, and compacted. This stabilizer material is available from Stabilizer Solutions, Phoenix, Arizona, (800) 336-2468. A discount is given for school use.

A third method of stabilizing a trail surface is the macadam construction technique. This method consists of a layer of non-woven geotextile covered with a 1/2'' to 1'' layer of aggregate chips or pea gravel which is lightly compacted. The aggregate is then coated with an asphalt emulsion at the rate of approximately 1.5 gallons per square yard. The asphalt emulsion will bond the aggregates together, as well as adhere to the geotextile which helps to disperse the weight of the trail traffic over a larger area. A thin layer of blotter sand can be spread over the surface to hide the black appearance of the asphalt.

For additional information on path stabilizers the USDA-Forest Service should be contacted at the San Dimas Technology & Development Center, Attn: Recreation Program Leader, 444 East Bonita Avenue, San Dimas, CA 91773, (909) 599-1267.

In wet areas or where there is a significant amount of surface water drainage, a raised boardwalk should be the "path" of choice to protect the natural environment, allow observation of the natural environment, and provide an accessible route. Boardwalks should be a minimum of 48'' wide. If 60'' x 60'' rest and passing areas are required due to slope, they can be enlarged and placed more frequently then every two hundred feet. As such, they can serve as study areas for groups of students without restricting traffic along the boardwalk. Even if not required, these areas are desirable. Protection along the edges of the boardwalk is required for wheelchair users, individuals with mobility problems, and for the general safety of students and staff. Boardwalks can be designed with a railing, however, a low railing should be designed so as not to hamper the view of the surrounding area and add significant cost to the project. An inexpensive but effective solution is to provide a simple wood edging (lip) along the walk and a single, low railing.

STRUCTURES

Whether built as part of a major school construction project, or as an enhancement to an existing school site, outdoor structures can help conserve ecological features and enhance instructional objectives.

Ecological features like ponds, streams, wetlands, meadows and woodlands are home to many animals. Structures help shield sensitive plants and wildlife from human disturbance and define physical spaces where student activities may be concentrated. Structures also help address the seemingly incompatible juxtaposition of sports fields, playgrounds, parking lots and school site habitats.

Structures create unique opportunities for students to interact with, observe and research the natural environment at their own pace. Such opportunities enhance instructional objectives in math, science, language arts, creative arts, social studies and other disciplines. Structures make outdoor instruction more comfortable and convenient. They create spaces for structured learning that facilitate behavior management outside the classroom.

School site habitat structures — their planning, design, construction and utilization — provide opportunities for school partnerships with the community, conservation organizations, arts associations, local businesses, media outlets and government agencies. These interactions may demonstrate to students career opportunities in the areas of environmental planning, ecotourism, journalism and wildlife management.

While many kinds of structures may be included in a school site habitat or outdoor classroom, several types have been used successfully in Maryland and are included here. They include: seating, wildlife viewing blinds, and outdoor classroom buildings and storage.

Planning, Design, and Construction

Seating, Work Surfaces

Tables, benches, and other seating structures commonly are included in outdoor classrooms. Planning, design and construction considerations will help determine the best seating structures for your site. One of the first considerations is whether the seating structures will be stationary (fixed in place) or mobile. Stationary seating may be secured so it will not tip on uneven surfaces. Stationary seating can be constructed using heavy, durable materials and does not require storage. Stationary seating may require a water permeable substrate, such as wood chips or stone pavers. Careful attention should be given to the placement of stationary seating. Noisy, high activity areas, low lying wet areas, and areas that offer no protection from heat and wind should be avoided. Stationary seating may be more vulnerable to vandalism. Placing the seating area where it can be monitored visually may be an important consideration.

While stationary seating offers many benefits, it does not offer the option of moving the seating structures to where "the action is." Movable chairs or benches may easily be placed in a meadow filled with blooming daisies, beside a stream covered by racing water striders, or beneath an oak dropping its golden leaves.

Another consideration is the grade level and number of students who will be using the seating. Younger students require lower seating. Benches, instead of chairs, may better accommodate large class sizes. Special needs students may require especially stable seating with back and arm supports.

The type of activities is another consideration. While seating alone may be adequate for reading or observation, tables may be required for writing, research and arts activities.

Seating structures are inexpensive to moderate in cost and are limited in design only by the imagination of the planning team, teachers and students. Simple natural objects like large stones, logs, or stumps may be fashioned into inexpensive outdoor seating. Preassembled picnic tables or picnic table kits provide a commonly used outdoor seating structure at a low cost. In some cases, individual, mobile seating may be desirable.

Wildlife Viewing Blinds

Wildlife viewing blinds can be one of the most engaging structures in a school site habitat. Patient students, rewarded with an intimate glimpse of a young squirrel struggling to outsmart a student-designed, squirrel-proof bird feeder, for example, gain experience and confidence in their ability to apply principles of science and technology. Wildlife viewing blinds, however, represent an investment and require careful planning and design.

Planning and design begins with planners' and educators' expectations about the opportunities a wildlife viewing blind may provide. The best wildlife viewing blinds are those built in places where there is an existing, high level of wildlife activity and where that activity would be affected by human disturbance. Building a wildlife viewing blind will not bring wildlife to your site and a blind is not required to observe animals that are accustomed to human activity. While a new pond or wetland eventually may attract wildlife species that require a viewing blind to observe, expectations need to be realistic about the wildlife viewing opportunities, the student interest that will be generated, and the wildlife value of your site.

Once the kind of wildlife viewing opportunities have been determined, the real planning process can begin. Key considerations are site and access.

The habitat features of the site and the location of the blind within the site are key to the blind's success. The best sites are those that include a variety of habitats and ecotones — the zones where different habitats meet. For example, a pond or wetland bordered by a woodland on one side and a meadow on the other would optimize the diversity of wildlife that may be observed from the blind. The blind needs to be located near enough to wildlife activity for easy viewing and far enough away to prevent human disturbance.

The blind also must be sited to take advantage of natural lighting. An east-facing blind, for example would be good for afternoon viewing, but the rising sun may hamper morning viewing. A north facing blind will provide better foreground lighting, and give photographs and viewing a greater sense of depth. Often, there are few choices about viewing direction. In these cases it is important to anticipate and work around the blinds viewing limitations.

Another planning concern is access. A blind is successful if it can be entered and exited without disturbing the wildlife it was built to observe. This requires physical barriers and landscaping to shield human activity from the observation area. Wide earthen berms provide the most durable physical structures to facilitate undetected entry and exit. Once planted with vegetation berms absorb sound and, if positioned correctly, help conceal the viewing blind itself. Berms may be built using the soil removed to create a pond or wetland. They need not be more than about five feet tall, especially if they are planted with native evergreens. An alternative to earthen berms is stockade fencing, also planted with sound absorbing vegetation. Without these barriers, disturbed wildlife may not return to the observation area within a given period.

Once the site and access questions have been addressed the pre-construction planning of the wildlife viewing structure can proceed. Key issues to address are design and context. In the case of wildlife viewing structures, construction designs can be conceptualized by students and finalized by a professional designer. Students can design and install native plant landscaping and wildlife feeding stations that will enhance the use of the blind.

Many school sites do not have large natural areas and many do not merit a large, traditional-style observation blind. In these cases, low-cost alternatives may provide more appropriate wildlife viewing opportunities. For example, songbird feeding stations may be viewed from behind a section (or sections) of stockade fencing with small viewing openings cut at different heights. Stationary or movable benches can be placed on the student side of the fence to improve viewing comfort. Positioning this structure beneath a large tree or enhancing the fencing with native plant landscaping will provide a more concealed feeling for the student observer.

In one variation of the stockade fence viewing structure, fence sections are placed along three sides of a square. Using this design, a simple sloped roof can be added on top of fence posts that extend beyond the top of the fencing. Additional fencing or plantings can be used to create a concealed entryway. The ground where students are standing or sitting can be covered with wood chips. Wood chips are preferred because they make little sound when they are walked on and they are easier to maintain than grass or natural vegetation. In another variation, the fencing sections may be positioned in a concave arc.

To receive optimum use, regardless of the construction design, a wildlife viewing blind likely will need to be large enough to accommodate an entire class of about 25 students. The blind also will need to accommodate special needs students.

Some schools have constructed observation blinds as small as eight-feet by eight-feet. These structures work well for four to six students, but cannot accommodate an entire class. In places where smaller structures are used, special consideration should be given to the problems associated with the supervision of students using the structure, as well as those engaged in activities elsewhere.

Red Shouldered Hawk

Observation blinds, large enough to accommodate 25 people, were first built by environmental educators in British nature centers. Structures with this capacity need to be about 36 feet long and 10 feet wide. Entryways need to provide universal access.

The small viewing openings need to be low enough that seated students comfortably can see through them. They need to be covered by hinged shutters that can be opened easily and quietly. The shutters, opened only during observation periods, help minimize wildlife disturbances as students enter and exit. Stationary, tempered glass successfully has been used in some viewing blinds. The glass helps reduce noise levels and prevents students disturbing wildlife by sticking hands or objects out the windows.

Seating must be the appropriate height for the size of the students. Movable, stable bench seating works well. Hinged work surfaces, that can be raised or lowered, may be installed below the viewing openings. Exterior openings must be designed to prevent bright, backlit silhouettes of entering students from disturbing wildlife. This easily is accomplished by entry and exit doors separated from the interior viewing room by short hallways.

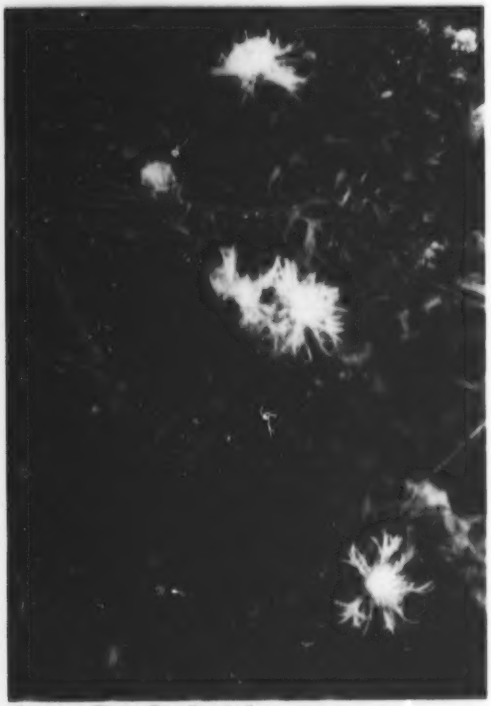
Graphics display panels along the back wall of the viewing blind may display student work or chart research project progress.

Locking exterior doors may help prevent vandalism and inappropriate use.

Air circulation vents, placed near the ceiling will alleviate excessive heat build-up on sunny days. Hinged shutters installed over the vents will reduce air circulation and trap heat on cold days.

Context is an important pre-construction consideration. A wildlife viewing blind is a unique opportunity to model ecologically sustainable design practices. The viewing blind unobtrusively should fit into the natural landscape. In many cases, the structure's design will reflect the site's natural features.

Special attention should be given to non-toxic building materials, finishes and colors. Wildlife viewing blinds in wooded areas may have log siding, stained to match the bark color of local trees. A blind in an area of rolling meadow may be built of cinderblock, covered by soil and topped with a living sod roof. Blinds near a marsh may be "brushed" with wetland vegetation the way duck hunters conceal hunting blinds. Wildlife species that are suspicious of human activity will be suspicious of anything that looks like a "building."



Eastern Tiger Swallowtail

Many blinds are built on slightly elevated wooden deck platforms. A raised floor helps the view and is necessary if the blind is near enough to a water body that it may get wet during seasonal flood events. A wooden floor is easily swept clean.

While materials for a small observation blind may cost less than $2,000, materials for a structure large enough to accommodate an entire class will cost about $15,000 to $20,000. The advantage to the larger structure is that it can be used more regularly because it does not require additional adults to supervise students working in other areas. It also is easier for more than one class to use it each day. The larger blind provides greater flexibility and expanded opportunities to develop observation-based activities that help educators and students meet learning goals.

Outdoor Classroom Buildings and Storage

Most school yard habitats do not require auxiliary outdoor classroom buildings or storage areas. However, some schools have constructed covered pavilions with water and electrical power to use as outdoor labs. Covered pavilions offer some protection from weather. Screen-sided pavilions offer additional protection from biting insects. This may be a greater concern for schools located near wetland areas where biting flies, mosquitoes and other organisms may cause discomfort for students and teachers. Many examples of pavilions can be seen in public parks. Size, cost and design all will depend on a school's unique needs.

Storage areas can most effectively be provided using preconstructed storage sheds. These often are used for equipment storage by sports programs. They come in a variety of sizes and can be painted to blend with other school structures. They can be locked and even relocated as your storage needs change.

Amphitheaters

Outdoor amphitheaters provide a structured setting in which students may engage in a variety of activities. They provide areas where whole class instruction and discussion can occur. They provide an alternative and appropriate setting where working groups of students can report ecological data or research findings to classmates. Amphitheaters also provide a setting in which students can design and perform drama programs.

Many schools have small outdoor amphitheaters. They are relatively inexpensive to construct and maintain. While amphitheaters often are constructed on gently sloped ground, they also may be constructed on level surfaces. Whether on a sloped or flat surface, amphitheaters should be located in areas where they are shaded from direct sunlight. If no shaded area is available, a simple pergola-type structure may be built to cover the amphitheater area. Native vines, such as trumpet vine may be grown on the overhead lattices of the pergola to create adequate shade and allow dappled sunlight to illuminate the amphitheater area.

An amphitheater typically consists of benches, arranged in a semi-circular pattern around a central raised deck or stage. As with other seating, the benches may be stationary or mobile. Most amphitheater benches are stationary. They easily can be constructed from pressure treated posts, set in deep post holes, and topped with a two-inch by twelve-inch lumber seat.

Small stages, usually about eight-feet by 10-feet in size, are built using standard deck construction methods. They should be elevated but must have access for individuals with disabilities. More elaborate stages may include eight to 10 foot tall vertical upright posts with horizontal cross beams on which backdrops and drama props may be supported.

The area around the stationary benches and stage easily can be covered with a thick layer or wood mulch. Underlying the mulch with a landscape weed barrier will reduce maintenance. The mulch will eliminate the need for mowing and trimming and also reduce bare earth and mud.

Some amphitheaters may include decorative or safety lighting, especially if they will be used at night.

HABITAT COMPONENTS

Outlined in this section are additional habitat features and suggestions for other outdoor amenities.

Habitat Features

Logs - Rotting logs are habitat for many insects, salamanders and small mammals. Logs are good lessons in the process of decay and the life associated with it. Logs can be placed in any of the habitat types. Partially submerged logs in wetlands or ponds provides a place for turtles and frogs to sun.

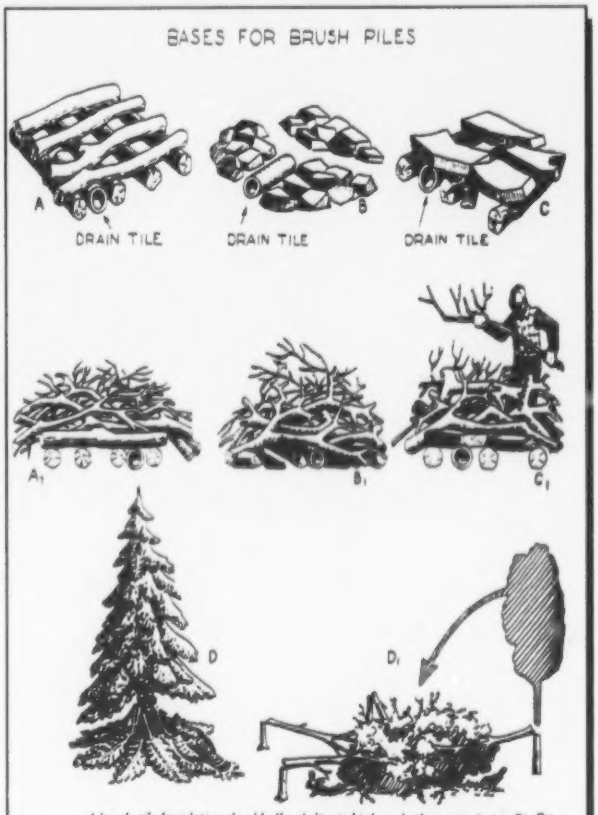
Snags - Standing dead trees or snags provide for cavity nesting birds including woodpeckers and chickadees. Insects within snags attract a variety of birds. Predatory birds perch on snags for a better view of prey.

Brushpiles - Brushpiles provide excellent cover for rabbits, chipmunks, skunks, small birds, and insects. Place brushpiles in woodlands and along wooded edges. Discarded Christmas trees can be used as a brushpile.

Water - If there is not room for a sizeable wetland or pond, consider a way to provide water for wildlife. A half barrel filled with water works well. If the soil has enough clay, simply dig a few shallow holes and let the rain fill them. Dripping water into a puddle is irresistible to birds. Check with a local library or nursery for directions on building a small lined pond.

Nesting Boxes - Nesting boxes are a good habitat amendment for cavity nesting birds. Bat boxes and squirrel boxes can also be built. A bluebird trail can be built by placing several nesting boxes at least 100 yards apart, preferably along a forest edge or in a meadow. Boxes need to be placed on posts with predator guards. Boxes should be monitored and cleaned after each brood. Many birds may use bluebird boxes for nesting. All birds, except house sparrows and starlings, are protected by law.

Feeders - Place bird feeders near protective shrubs and trees to attract more birds. A bird feeder project should have some long-term benefit for the students and not be a one-time project.



A brush pile foundation should offer shelter to birds and other animals (A–C). On top of these foundations pile branches (A1–C1). A living shelter is formed by slicing off underside branches of a conifer (D) or felling trees (D1).

Figure 11

Chapter 5

Appendices

Appendix A: **Funding Sources**

Appendix B: **Organizations**

- Forest Service, Maryland Department of Natural Resources
- Forestry Boards
- Soil Conservation District Offices
- Maryland Cooperative Extension Offices

Appendix C: **Native Plants**

Appendix D: **References**

FUNDING SOURCES

There is a wide variety of funding sources available to Maryland educators to support school site habitat projects, perhaps more than in any other state. In addition to traditional local and community fund-raising sources schools often depend on, many local and state agencies and nonprofit foundations that have programs designed for school site habitat restoration. Projects that connect with environmental restoration efforts, the Chesapeake Bay for example, are often especially fundable.

Not all projects will need funding. A reforestation project might be done with trees provided by the local county forestry board. Funding needs, and opportunities for funding, will vary depending on the type of project and size of project. The most expensive projects are those requiring large amounts of capital improvements. Most projects are much smaller and will cost less than $1,000. Larger projects can be done through a series of small grants.

One of the best sources of information about funding opportunities, as well as technical assistance for your project, will be state or local natural resource agency personnel. Many are listed in this publication, in the phone book, or on the Internet. School system environmental or outdoor education staff can be very helpful in finding resource agency help and funding opportunities.

In the last few years, hundreds of school site projects have been completed by students and teachers. Most of these have been designed as part of educational programs to improve student performance. Many others were part of statewide environmental restoration efforts. The following list includes major funding opportunities that have been supporting school site projects for many years.

The **Chesapeake Bay Trust** (CBT), a state foundation, is a source of funds and information. CBT has provided more than $500,000 per year to schools for projects connected to the restoration of the Chesapeake Bay. Funds collected through the sale of special license plates ("Treasure the Chesapeake" plates) and from a state income tax check-off program are available through a simple grant program. In addition to large grants approved regularly, projects for less than $1,000 can often be made in less than one month. Wetland restoration, riparian reforestation programs, and projects that slow or stop non-point source erosion, are examples of projects that receive CBT funds. More information and grant applications are available at (410) 974-2941 or at the CBT website.

The **Maryland Department of Natural Resources** (DNR) has several programs that provide assistance and funds to schools. Two programs frequently used by schools are the **Aquatic Resources Education** (ARE) program and DNRs forestry programs. The ARE program makes $1,000 grants available to teachers who attend ARE training workshops. Call (410) 260-8716 for information and the workshop schedule. Forestry programs include Arbor Day programs, local County Forest Conservancy Board programs, and Stream ReLeaf, a program to reforest Maryland stream buffer areas. For more information check Appendix B in this guide, the DNR website, or call (410) 260-8513.

The environmental education program of the **Maryland State Department of Education**, call (410) 767-0324, provides funds to school systems in support of their efforts to improve student performance through environmental programs. Many habitat projects can easily be designed to incorporate student achievement and problem-solving activities.

The "Partners for Fish and Wildlife Program" of the **U.S. Fish and Wildlife Service** (USFWS) has a limited amount of funding to assist schools with wetland, stream, meadow, or reforestation projects. Grants are usually less than $1,000. Some technical assistance is also available. Call the Chesapeake Bay Field Office of the USFWS at (410) 573-4500 for information about these opportunities.

Many national nonprofit environmental and educational organizations provide funds and other sources of assistance to schools. These include the National Arbor Day Foundation, the Federation of Garden Clubs, and the U.S. Environmental Protection Agency. One excellent source of assistance is the **National Wildlife Federation**. Their Internet web site, http://www.nwf.org/habitats/schoolyard/creating/index.html, lists many resources.

There are opportunities to include a school site project as part of new school construction or as part of major school renovation and/or addition projects. Please refer to Chapter 2, The Planning Process.

ORGANIZATIONS

MARYLAND DEPARTMENT OF NATURAL RESOURCES
FOREST SERVICE
Regional & County Offices

REGIONAL OFFICES

WESTERN REGION
3 Pershing Street
Cumberland, MD 21502
(301) 777-2137
(301) 777-2197 FAX

SOUTHERN REGION
13022 8th Street
Bowie, MD 20719
(301) 464-3065
(301) 464-0462 FAX

CENTRAL REGION
2 S. Bond Street
Bel Air, MD 21014
(410) 836-4551
(410) 836-4552 FAX

EASTERN REGION
201 Baptist Street, Suite 22
Salisbury, MD 21801
(410) 543-6745
(410) 543-6768 FAX

COUNTY OFFICES

ALLEGANY
3 Pershing Street, Room 101
Cumberland, MD 21502
(301) 777-2027
(301) 777-2197 FAX

ANNE ARUNDEL
Forestry Education Center
8023 Long Hill Road
Pasadena, MD 21122
(410) 768-0830
(410) 768-7134 FAX

BALTIMORE
Cub Hill Ranger Station
9405 Old Harford Road
Baltimore, MD 21234
(410) 665-5820
(410) 882-9961 FAX

CALVERT
Post Office Box 1136
Prince Frederick, MD 20678
(410) 535-1303
(410) 535-4737 FAX

CAROLINE/TALBOT
Martinak State Park
105 Deep Shore Road
Denton, MD 21629
(410) 479-1623
(410) 822-1800
(410) 479-1814 FAX

CARROLL
328a E. Nicodemus Road
Westminster, MD 21157
(410) 848-3291
(410) 848-9450
(410) 848-3291 FAX

CECIL
Black Hill Ranger Station
130 McKinneytown Road
North East, MD 21901
(410) 287-5777
(410) 287-0010 FAX

CHARLES
P.O. Box 2746
La Plata, MD 20646
(301) 934-2543
(301) 934-8685 FAX

DORCHESTER
4329 Golden Hill Road
Church Creek, MD 21622
(410) 228-1861
(410) 228-6071 FAX

FREDERICK
8602 Gambrill Road
Frederick, MD 21701
(301) 473-8417
(301) 473-4570
(301) 473-8577 FAX

GARRETT
1728 Kings Run Road
Oakland, MD 21550
(301) 334-3296
(301) 334-2737

HARFORD
2 S. Bond Street
Bel Air, MD 21014
(410) 836-4551
(410) 836-4552 FAX

HOWARD/MONTGOMERY
17400 Annapolis Rock Road
Woodbine, MD 21797
(301) 854-6060
(410) 442-2080
(410) 442-2126 FAX

KENT/QUEEN ANNE'S
120 Broadway Avenue
Centreville, MD 21617
(410) 758-5254
(410) 758-5018 FAX

PRINCE GEORGE'S
Huntington Community Center
13022 8th Street
Bowie, MD 20720
(301) 464-3065
(301) 464-0462 FAX

ST. MARY'S
Carter Building
Leonardtown, MD 20650
(301) 475-8551
(301) 475-4036 FAX

SOMERSET
10990 Market Lane
Princess Anne, MD 21853
(410) 651-2004
(410) 651-0397 FAX

WASHINGTON
14038 Blairs Valley Road
Clear Spring, MD 21722
(301) 791-4733
(301) 842-0072 FAX

WICOMICO
Powellville Work Center
6095 Sixty Foot Road
Parsonsburg, MD 21849
(410) 543-1950
(410) 543-2888 FAX

WORCESTER
Nassawango Work Ctr
6572 Snow Hill Road
Snow Hill, MD 21863
(410) 749-2206
(410) 749-0628 FAX

Forestry Boards

ALLEGANY
729 Illinois Street
Cumberland, MD 21502
(301) 729-1109

ANNE ARUNDEL
915 Harwood Road
Harwood, MD 20776
(301) 261-7527

BALTIMORE
7636 Donny Terrace
Kingsville, MD 21087
(410) 592-2400

BALTIMORE CITY
4 Drew Court
Baldwin, MD 21013
(410) 396-0352

CALVERT
3016 Abington Manor Drive
Huntingtown, MD 20639
(410) 535-6813

CAROLINE
10161 River Landing Road
Denton, MD 21629
(410) 479-2827

CARROLL
4036 Schalk Road, #2
Millers, MD 21107
(410) 833-4700

CECIL
100 Mill Lane
North East, MD 21901
(410) 287-5801

CHARLES
P.O. Box 1925
La Plata, MD 20646
(301) 934-1020

DORCHESTER
2104 Wingate-Bishops Head Rd.
Wingate, MD 21675
(410) 397-8909

FREDERICK
12213 Wildcat Road
Myersville, MD 21773
(301) 293-2697

GARRETT
61 Paradise Heights
Oakland, MD 21550
(301) 334-6950

HARFORD
705 Estates Court
Bel Air, MD 21015
(410) 597-7943

HOWARD
5009 Worthington Way
Ellicott City, MD 21043
(410) 465-0654

KENT
210 Manor Avenue
Chestertown, MD 21620
(410) 778-1157

MONTGOMERY
9501 Bruce Drive
Silver Spring, MD 20901
(301) 585-8818

PRINCE GEORGE'S
David Bourdon
SCS Co. Adm. Bldg, Rm 1101
Upper Marlboro, MD 20772
(301) 574-5162

QUEEN ANNE'S
201 Dogwood Lodge Lane
Crumpton, MD 21629
(410) 758-3676

ST. MARY'S
321-B Callahan Drive
Great Mills, MD 20634
(301) 862-5535

SOMERSET
32203 Hess Road
Marion, MD 21838
(410) 957-3411

TALBOT
11550 Plugge Road
Cordova, MD 21625
(410) 822-5476

WASHINGTON
3138 Kaetzel Road
Gapland, MD 21736
(301) 432-6582

WICOMICO
9045 Riggin Road
Mardela Springs, MD 21837
(410) 749-5951

WORCESTER
P.O. Box 156
Berlin, MD 21811
(410) 641-2200

Soil Conservation
District Offices

ALLEGANY
11602 Bedford Road, NE
Cumberland, MD 21502
(301) 777-1747 Ext. 4

ANNE ARUNDEL
2662 Riva Road, Suite 150
Annapolis, MD 21401
(410) 222-7822

BALTIMORE
9831 Van Buren Lane
Cockeysville, MD 21030
(410) 666-1188 Ext. 3

CALVERT
65 Duke Street, P.O. Box 657
Prince Frederick, MD 20678
(410) 535-1521 Ext. 3

CAROLINE
640 Legion Road, Suite 3
Denton, MD 21629
(410) 479-1202 Ext 3.

CARROLL
1004 Littlestown Pike, Suite B-2
Westminster, MD 21157
(410) 848-6696

CECIL
Upper Chesapeake Corp Ctr.
101 Chesapeake Blvd, Suite A-3
Elkton, MD 21921
(410) 398-4411 Ext. 3

CHARLES
101 Catalpa Drive, Suite 106-C
La Plata, MD 20646
(301) 934-9588 Ext. 3

DORCHESTER
501 Court Lane, Room 213
Cambridge, MD 21613
(410) 228-5640 Ext. 3

FREDERICK
92 Thomas Johnson Drive
Suite 230 North Amber
Frederick, MD 21702
(301) 695-2803 Ext. 3

GARRETT
1916 Maryland Highway, Suite C
Mountain Lake Park, MD 21550
(301) 334-6950 Ext. 3

HARFORD
1208 Churchville Road, Suite 201
Bel Air, MD 21014
(410) 838-6181 Ext. 3

HOWARD
9025 Chevrolet Drive, Suite J
Ellicott City, MD 21042
(410) 465-3180

KENT
122 Speer Road, Suite 4
Chestertown, MD 21620
(410) 778-5150 Ext. 3

MONTGOMERY
18410 Muncaster Road
Derwood, MD 20855
(301) 590-2855

PRINCE GEORGE'S
14741 Governor Oden Bowie Drive
Upper Marlboro, MD 20772
(301) 574-5162 Ext. 2

QUEEN ANNE'S
505 Railroad Avenue, Suite 3
Centreville, MD 21617
(410) 758-3136 Ext. 3

ST. MARY'S
22660 Washington Street
P.O. Box 810
Leonardtown, MD 20650
(301) 475-8402/5856

SOMERSET
30730 Park Drive
Princess Anne, MD 21853
(410) 651-0390/1575 Ext. 3

TALBOT
215 Bay Street
Easton, MD 21601
(410) 822-1344 Ext. 3

WASHINGTON
1260 Maryland Avenue, Suite 101
Hagerstown, MD 21740
(301) 797-6821/6820

WICOMICO
2322 B Goddard Parkway
Salisbury, MD 21801
(410) 546-4777 Ext. 3

WORCESTER
304 Commerce Street
Snow Hill, MD 21863
(410) 632-5439 Ext. 3

Maryland Cooperative Extension Offices

ALLEGANY
701 Kelly Road, Suite 101
Cumberland, MD 21502
(301) 724-3320

ANNE ARUNDEL
Anne Arundel County Office Bldg
7320 Ritchie Highway, Suite 210
Glen Burnie, MD 21061
(410) 222-6758

BALTIMORE CITY
17 S. Gay Street
Baltimore, MD 21202
(410) 396-1753

BALTIMORE
9811 Van Buren Lane
Cockeysville, MD 21030
(410) 666-1022

CALVERT
County Services Plaza
P.O. Box 486
150 Main Street, Suite 300
Prince Frederick, MD 20678
(410) 535-3662

CAROLINE
207 South Third Street
Denton, MD 21629
(410) 479-4030

CARROLL
700 Agriculture Center
Westminster, MD 21157
(410) 386-2760

CECIL
Cecil County Court House
129 E. Main Street, Room 7
Elkton, MD 21921
(410) 996-5280

CHARLES
9375 Chesapeake Street, Suite 119
LaPlata, MD 20646
(301) 934-5403

DORCHESTER
County Office Building
P.O. Box 299
501 Court Lane, Room 208
Cambridge, MD 21613
(410) 228-8800

FREDERICK
330 Montevue Lane
Frederick, MD 21702
(301) 694-1594

GARRETT
1916 Maryland Highway, Suite A
Mt. Lake Park, MD 21550
(301) 334-6960

HARFORD
P.O. Box 663
2335 Rock Spring Road
Forest Hill, MD 21050
(410) 638-3255

HOWARD
3525-L Ellicott Mills Drive
Ellicott City, MD 21043
(410) 313-2707

KENT
Kent County Public Works Complex
709 Morgnec Road, Suite 202
Chestertown, MD 21620
(410) 778-1661

MONTGOMERY
18410 Muncaster Road
Derwood, MD 20855
(301) 590-9638

PRINCE GEORGE'S
6707 Groveton Drive
Clinton, MD 20735
(301) 868-9366

QUEEN ANNE'S
505 Railroad Ave, Suite 4
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(410) 758-0166

ST. MARY'S
21580 Peabody Street
P.O. Box 663
Leonardtown, MD 20650
(301) 475-4482

SOMERSET
30730 Park Drive
Princess Anne, MD 21853
(410) 651-1350

TALBOT
P.O. Box 519
125 Bay Street
Easton, MD 21601
(410) 822-1244

WASHINGTON
1260 Maryland Avenue
Hagerstown, MD 21740
(301) 791-1304

WICOMICO
P.O. Box 1836
Salisbury, MD 21802
(410) 749-6141

WORCESTER
P.O. Box 219
Snow Hill, MD 21863
(410) 632-1972

NATIVE PLANTS

Scientific Name Common Name	Region	Sun Preference: Soil Moisture; Soil Tolerances	Ornamental Characteristics	Wildlife Value: Food and Cover; Species	Comments, Concerns; Uses
DECIDUOUS TREES					
Acer rubrum Red Maple	C/P/M	Sun to partial sun; wet to dry; tolerates flooding, drought, and compaction	Haze of small red flowers early spring; yellow to red fall color varies; new twigs reddish	High: seeds, sap; SB, M	Acid Soils; children play with winged samara
Acer succharum Sugar Maple	M	Sun to partial sun; Moist to well drained	Yellow, orange, and red fall color on same tree	Medium to high; seeds, sap; SB, GB M	Lawn tree, tap for maple syrup, wood used for furniture
Betula nigra River Birch	C/P/M	Sun to partial sun; wet to well drained, tolerates flooding	Fine textured pendulous branches; exfoliating bark reddish brown; yellow fall color	High: fruit; sap; cavity nesting; SB, GB, M	Fast growing; prefers acid soil; wood used for furniture
Fraxinus americana White Ash	P/M	Sun to partial sun; moist to well drained, tolerates drought and compaction	Dark green leaves; yellow to maroon fall color; attractive bark	Low: seed, foliage; SB, M	Wood used for baseball bats
Liquidambar styraciflua Sweetgum	C/P	Sun to part sun; moist to well drained, tolerates compaction	Yellow, orange, red, and/or maroon fall color	Low: seeds; M	Fast growing; large seed capsules can be messy but used for play
Quercus palustris Pin Oak	C/P	Sun; wet to well drained, tolerates flooding and drought	Red fall color, bronze leaves persist in winter; lower branches droop to ground	High: acorns, twigs; SB, GB, M	Acid soil
Quercus phellos Willow Oak	C/P	Sun; wet to well drained, tolerates flooding	Fine textured branches; willow-like leaves	High: acorns; twigs; SB, GB, M	Leaves drop continuously for 6 weeks
Quercus prinus Chestnut Oak	P/M	Sun to partial sun; well drained to dry, tolerates drought	Leaves like American Chestnut; amber fall color	High: acorns, twigs; SB, GB, M	Low heavy horizontal branches, good for swings or climbing
Quercus rubra Red Oak	P/M	Sun to partial sun; well drained	Red fall color	High: acorns, twigs; SB, GB, M, BF	
Salix nigra Black Willow	P/M	Sun to partial sun; wet to moist, tolerates flooding	Haze of yellow-green flowers early spring; pale foliage	Medium: twigs, foliage, nesting; SB GB, M	Fast growing, may be messy; wood used for charcoal
Tilia americana American Linden, Basswood	P/M	Sun to shade; moist to well drained	Dark green foliage	Low: nut like fruit, pollen	Needs large space, bees make honey from it

REGION: C=Coastal Plain, P=Piedmont, M=Mountain and Valley
SUN: Prefers Sun, partial shade, shade
SOIL: Adapts to wet, moist, well drained, dry situations; tolerates flooding, drought, compaction
WILDLIFE SPECIES: SB=songbirds, GB=gamebirds and/or waterfowl (ducks, quail, grouse), M=mammals (squirrels, rabbits, chipmunks and/or deer)

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Scientific Name **Common Name**	**Region**	**Sun Preference: Soil Moisture; Soil Tolerances**	**Ornamental Characteristics**	**Wildlife Value: Food and Cover; Species**	**Comments, Concerns; Uses**
EVERGREEN TREES					
Ilex opaca American Holly	C/P	Sun to partial shade; moist to well drained	Dark leathery leaves; persistent red berries on female plants	High: berries, sap; nesting; SB, GB, BF	Prefers rich moist acid soil, need male and female plants for fruit; susceptible to leaf minor
Juniperus virginiana Eastern Red Cedar	C/P	Sun; well drained to dry, tolerates drought	Narrow from sometimes irregular dark dense foliage; blue berries; shredding reddish brown black	High: berries; SB, GB, BF, M	Tolerates alkaline soil, short lived, don't plant near apple trees; used for pencils, cedar chests; moth repellant, gin
Pinus strobus Eastern White Pine	M	Sun to partial shade; moist to dry	Loose open habit; long soft fragrant bluish-green needles	Moderate to high: seeds, sap; SB, GB, M	Not tolerant of pollution, prefers acid soils
Pinus taeda Loblolly Pine	C	Full sun; wet to moist tolerates drought	Loose open habit; long stiff yellow-green needles; not ornamental	Moderate: seeds, sap; nesting; SB, M	Fast growing, prefers acid soil
UNDERSTORY TREES					
Amelanchier arborea Shadblow, Serviceberry, Juneberry	P/M	Partial sun to shade; moist to dry	Small produse white flowers in early spring; smooth grey bark; dry red to purple fruit	High: berries, twigs; nesting, cover; SB, M	Available in single trunk or multi-stemmed, prefers acid soil
Carpinus caroliniana Hornbeam, Ironwood Blue Beech	C/P/M	Partial shade to shade, wet to well drained; tolerates drought	Smooth light grey bark appears muscled; orange-red fall color	Moderate: seeds, twigs, leaves; SB, GB, M	Slow growing
Cercis canadensis Redbud	C/P/M	Sun to partial shade; moist to dry, tolerates drought	Pinkish-purple flowers along branches; yellow fall color; large heart shaped leaf; legume pod persists into winter	Low: seeds; M	Some disease problems, tolerates alkaline soil
Chionanthus virginicus Fringe Tree	C/P	Sun to partial shade; wet to dry	White flowers in hanging clusters; late spring or early summer	Moderate: berries on female plants; SB, M	Acid soil
Magnolia virginiana Sweetbay Magnolia	C	Partial sun; wet to moist	Large solitary fragrant white flowers; long pink fruit pod; semi-evergreen; thick shiny leaves	Low: seeds; M	Acid soil
Ostrya virginiana Hophornbeam	P/M	Sun to shade; moist to dry, tolerates drought	Yellow fall color, leaves persist in winter	Moderate: nuts; SB, GB, M	Slow growing, may be hard to transplant

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Scientific Name **Common Name**	**Region**	**Sun Preference: Soil Moisture; Soil Tolerances**	**Ornamental Characteristics**	**Wildlife Value: Food and Cover; Species**	**Comments, Concerns; Uses**
SHRUBS					
Aronia arbutifolia Red Chokeberry	C/P/M	Sun to partial sun: wet to well drained, tolerates flooding	Small white flowers; orange-red fall color; bright red fruit persists in winter	Moderate: fruit; SB, GB, M	6-12' In masses
Cephalanthus occidentalis Buttonbush	C/P/M	Sun to partial sun; wet to moist, tolerates flooding	Round white flowers in early summer	High: leaves; seeds; nectar; cover; SB, GB, M, hummingbirds	6-12' In masses
Clethra alnifolia Sweet Pepperbush	C	Sun to partial sun; wet, tolerates flooding and compaction	White to pinkish flower spikes; dry fruit capsules persist in winter	Moderate: nectar; attracts butterflies, bees, insects	3-8' Prefers acid soil; suitable for specimen or group
Cornus amomum Silky Dogwood	C/P	Sun to shade; wet to well drained, tolerates flooding	Smooth dull red twigs; small sparse whitish flowers	High: berries, twigs; SB, GB, M	6-9' In masses
Cornus racemosa Grey Dogwood	P/M	Sun to shade; wet to dry, tolerates drought	Slender grey twigs; small whitish flowers and fruit with red stems	High: berries, twigs; SB, GB, M	6-9' In masses
Hammamelis virginiana Witchhazel	P/M	Sun to shade; moist to dry	Small yellow fragrant flowers late fall, yellow fall color	seeds, GB, M	12-20' Capsules spit out seeds, once used for dividing rods, witchhazel lotion from bark
Ilex glabra Inkberry	C	Sun to partial sun; wet to moist, tolerates flooding and compaction	Small dark shiny evergreen leaves	High: berries, nectar; SB, M	6-8' Acid soil, poisonous fruit; use for hedges, groups, masses
Ilex verticillata Winterberry	C/P/M	Sun to partial sun; wet to moist, tolerates flooding	Bright red persistent berries on female plant; grey twigs	High: berries and cover; SB, M, BF	6-8' Need male and female plant, poisonous fruit; slow growing; beautiful in winter, specimen or group
Lindera benzoin Spicebush	C/P/M	Sun to shade; moist to dry, tolerates flooding	Small clusters of yellow flowers early spring; fragrant leaves and twigs; red berries; yellow fall color	High: berries on female plant; SB, GB M, BF	6-12' Prefers acid soil
Myrica pensylvanica Northern Bayberry	C	Sun to partial sun; wet to dry, tolerates flooding, drought and compaction	Small waxy blue-grey berries; all parts aromatic when crushed; light grey twigs	High: berries, cover, nesting; SB, GB, M	5-12' Acid soil; needs and female for good fruit; berries used to make candles
Myrica cerifera Southern Bayberry	C	Sun to partial sun; wet to dry, tolerates flooding, drought and compaction	Evergreen; waxy bluish-white berries, aromatic leaves	High: berries, cover, nesting; SB, GB, M	9-15' Acid soil; needs male and female for good fruit

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WILDLIFE SPECIES: SB=songbirds, GB=gamebirds and/or waterfowl (ducks, quail, grouse), M=mammals (squirrels, rabbits, chipmunks and/or deer)

Scientific Name Common Name	Region	Sun Preference: Soil Moisture; Soil Tolerances	Ornamental Characteristics	Wildlife Value: Food and Cover; Species	Comments, Concerns; Uses
Rhus copallina Shining Sumac, Flameleaf Sumac	C/P/M	Sun; dry, tolerates drought	Yellowish-green flower spike; hairy red berries on female plant; glossy leaves, bright red fall color	High: berries; SB, GB, M	20-30' Compact when young but fast growing
Rhus glabra Smooth Sumac	C/P/M	Sun; dry, tolerates drought and compaction	Yellowish-green flower spike; hairy red fruit on female plant; bright red fall color	High: berries; SB, GB, M	9-15' Fast growing; good on slopes
Vaccinium corymbosum Highbush Blueberry	C/M	Sun to partial sun; wet to dry, tolerates flooding	Clusters of white flowers in late spring; profuse edible blue berries, dark green foliage; red fall color	High: berries; SB, GB, M	6-9' Requires acid soil
Viburnum dentatum Arrowwood	C/P/M	Sun to partial sun; wet to dry, tolerant of flooding and drought	White flower clusters; blue-black fruit; red fall color may vary	Medium to high: berries; SB, GB, M	6-10' Wood used to make arrows by Native Americans, suckers freely in wet soils
Viburnum prunifolium Blackhaw	C/P/M	Sun to partial sun; wet to dry	White flower clusters; black fruit; red fall color	Medium to high: berries; SB, GB, M, butterflies	12-15' Hawthorn like habit, tolerates alkaline soil, edible fruit
Viburnum trilobum American Cranberry Bush	M	Sun to partial sun; moist to dry	White flower clusters; red berries, yellow to red fall color; gray twigs	Medium to high: berries; SB, GB, M	8-12' Can make jam from edible berries
Viburnum lentago Nannyberry	M	Sun to shade; moist to dry	Creamy white flower cluster; mottled fall color; berries change color red to black	Medium to high: berries; SB, GB, M butterflies	20' Often suckers, tolerates alkaline soil

REGION: C=Coastal Plain, P=Piedmont, M=Mountain and Valley
SUN: Prefers Sun, partial shade, shade
SOIL: Adapts to wet, moist, well drained, dry situations; tolerates flooding, drought, compaction
WILDLIFE SPECIES: SB=songbirds, GB=gamebirds and/or waterfowl (ducks, quail, grouse), M=mammals (squirrels, rabbits, chipmunks and/or deer)

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